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JOURNAL OF ECONOMIC ENTOMOLOGY

Official Organ American Association of Economic Entomologists

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CONTENTS

Proceedings of the Eighth Annual Meeting of the Pacific Slope Branch of the American Association of Economic Entomologists

Part I. Business Session 474

Part II. Papers and Discussions

A Discussion of *Eutettix tenella* Baker as Carrier of Curly-Top of Sugar Beets *C. F. Stahl* and *J. Franks Carsner* 476

Investigations of Beet Leafhopper, *Eutettix tenella* Baker, in Salinas Valley of California *H. H. P. Severin* 479

The Relation Between the Volatility and Toxicity of Nicotine in Dusts and Sprays *R. R. DeOng* 485

Spraying Equipment for Citrus Trees in California *F. B. Herbert* 494

Notes on Nicotine Dust Progress *R. E. Campbell* 497

What We may Expect from Biological Control? *H. S. Smith* 505

The Present Status of *Aphycus lounsburyi* How. in Southern California *H. M. Armitage* 511

The Successful Introduction and Establishment of the Ladybird, *Scymnus binaevatus* Mulsant, in California *H. S. Smith* 516

The History of Hydrocyanic Acid Gas Fumigation as an Index to Progress in Economic Entomology *R. S. Woglum* 518

The White Snail, *Helix pisana*, at La Jolla, California *A. J. Basinger* 522

Bees vs. Spraying *R. W. Doane* 527

Some Aspects of Biological Control in Hawaii *D. T. Fullaway* 531

A Simplified Method for Making Lubricating Oil Emulsions *A. M. Burroughs* and *W. M. Grube* 536

A Refrigerator for Shipping Live Insects *J. N. Summers* 539

The Pink Bollworm of Thurberia, *Thurberiphaga catalina* *J. L. Webb* 541

Notes on the Biology of *Dermacentrus pallidus* *G. W. Herrich* 548

Red Bug Control in Southern Pennsylvania *J. R. Stear* 553

Habrobracon juglandis Ashm. as a Parasite of *Plodia interpunctella* Hubn. *R. R. DeOng* 560

Scientific Notes 563

Editorial 565

Current Notes 566

Notes on Apiculture 567

Horticultural Inspection Notes 569

Medical Entomology 573

Thirty-sixth Annual Meeting of the American Association of Economic Entomologists
Cincinnati, Ohio

December 29, 1923 to January 2, 1924

THIRTY-SIXTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS, CINCINNATI, OHIO,

DECEMBER 29, 1923 TO JANUARY 2, 1924

The 36th annual meeting of the American Association of Economic Entomologists will be held at Cincinnati, Ohio, December 29, 1923, to January 2, 1924.

The meeting of the Sections of Apiculture and Horticultural Inspection will be held on Saturday, December 29, prior to the opening session of the general association. The opening business session of the association will be held Monday morning, December 31, at which time the address of the President will be delivered. Meetings will continue on Tuesday and Wednesday.

Sectional Meetings

The meeting of the Section of Apiculture will be held at 10 a. m., Saturday, December 29, in Room 11, McMicken Hall.

The Section of Horticultural Inspection will meet at 1.30 p. m., Saturday, December 29, in Room 11, McMicken Hall.

Other Meetings

The annual meeting of the American Association for the Advancement of Science and many of its sections and affiliated societies will be held December 27, 1923, to January 2, 1924.

The Sigma Xi dinner will be held at 6.45 p. m., December 28.

A demonstration lecture on "The Vacuum; There's something in it" will be given by Dr. Willis Rodney Whitney at 8.45 p. m., December 28 in the Hughes High School Auditorium.

The Entomological Society of America will open its meeting on Thursday, December 27, and continue its sessions on Friday and Saturday.

Entomologists interested in the Insect Pest Survey and in extension work will meet at 8 p. m., Monday, December 31. Members of this association interested in medical entomology will meet in joint session with members of Section N. The exact place of meeting will be announced later.

The Committee on Policy will meet at 6.30 p. m., Saturday, December 29, at Hotel Gibson.

Hotel Headquarters

Hotel headquarters for this association will be at the Hotel Gibson where rates have been secured ranging from $2.50 to $8.00 for single rooms and $4.00 to $10.00 for double rooms. All rooms are provided with bath. Members are requested to engage rooms promptly.

Railroad Rates

Reduced rates will be secured from some of the railroads. Members should obtain exact information prior to the time of the meeting from their local railroad agent or from Dr. Burton E. Livingston, Permanent Secretary, American Association for the Advancement of Science, Smithsonian Institution, Washington, D. C.

Dinner

The entomologists dinner will be held on Tuesday evening, January 1, at 7 p. m.

Membership

Applications for membership can be secured from the Secretary or from the Committee on Membership. These should be filled out, properly endorsed, and filed with the Membership Committee on or before December 29. Every application must be accompanied with a fee of $3.50 to cover dues and subscription to the JOURNAL for the year following election.

Program

SECTION OF APICULTURE

S. B. FRACKER, *Chairman* G. M. BENTLEY, *Secretary*

Saturday morning session, December 29, 10 a. m., Room 11, McMicken Hall

Address of the Chairman, S. B. Fracker, Madison, Wisconsin.

READING OF PAPERS AND DISCUSSIONS

1. Methods of Teaching Beekeeping—Symposium.
   A. Content of the Elementary Course. (10 minutes). J. S. Hine, Columbus, Ohio.
   B. Laboratory Methods. (10 min.) G. M. Bentley, Knoxville, Tenn.

C. Methods of Handling a Winter Short Course. (10 min.) H. F. Wilson, Madison, Wis.

D. Research Problems Adapted for Graduate Students. (10 min.) F. B. Paddock, Ames, Iowa.

E. Other Preparation Needed by Those Majoring in Beekeeping. (10 min.) F. E. Millen, Guelph, Canada.

2. The Honey Bee as an Agent in the Pollination of Apples, Pears and Cranberries. (10 min.) Ray Hutson, New Brunswick, N. J.

3. Seasonal Variation in Brood Population. (10 min.) W. J. Nolan, Washington, D. C.

4. Notes on Fall Feeding. (15 min.) F. B. Paddock, Ames, Iowa.

5. The Relation of Stores to Brood Rearing. (10 min.) J. H. Merrill, Manhattan, Kan.

6. The Storing and Ripening of Honey by Honeybees. (10 min.) (Lantern.) Wallace Park, Urbana, Ill.

7. Temperature Changes in the Hive During a Honey-flow. (10 min.) J. I. Hambleton, Washington, D. C.

8. Spreading Foulbrood by Un-intelligent Treatment. (10 min.) E. R. Root, Medina, Ohio.

9. The Relation of Bacillus Alvei to Confusing Symptoms in European Foulbrood. (10 min.) A. P. Sturtevant, Washington, D. C.

10. The Status of Isle of Wight Disease in Various Countries. (10 min.) E. F. Phillips, Washington, D. C.

Report of Committees.

Selection of Officers.

Adjournment.

Program

SECTION OF HORTICULTURAL INSPECTION

P. A. GLENN, *Chairman* E. R. SASSCER, *Secretary.*

Saturday Afternoon session, December 29, 1.30 p. m.; Room 11, McMicken Hall

Address by the Chairman, P. A. Glenn, Urbana, Illinois.

READING OF PAPERS AND DISCUSSIONS

1. Motion Picture—"Halting Foreign Plant Foes."

2. Recent Work of the Federal Horticultural Board. C. L. Marlatt.

3. Horticultural Inspection Methods in California. Lee A. Strong.

4. The Fight Against the Gipsy Moth in New Jersey. T. J. Headlee, New Brunswick, N. J.

5. Status of Hydrocyanic Acid Gas Treatment of Nursery Stock. J. J. Davis, LaFayette, Ind.

6. Important Foreign Insect Pests Collected on Imported Nursery Stock in 1923. E. R. Sasscer.

7. American Plant Production under Quarantine 37. R. Kent Beattie, Washington, D. C.

Reports of Committees.

Selection of Officers.

Adjournment.

Program

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLGGISTS

Monday morning, December 31, 10 a. m.; Chemistry Auditorium.

Report of the Secretary.

Report of Subscription Agent, by C. W. Collins, Melrose Highlands, Mass.

Report of the Executive Committee, by President A. G. Ruggles.

Report of the Delegate Appointed to Attend the International Conference of Phytopathology and Economic Entomology at Wageningen, Holland, by L. O. Howard, Washington, D. C.

Report of the Representative to the National Research Council, by George A. Dean, Manhattan, Kansas.

Report of the Committee on Policy, by P. J. Parrott, Geneva, N. Y.

Report of the Trustees of the Crop Protection Institute, by W. C. O'Kane, Durham, N. H.

Report of the Representatives on the Council of the Union of American Biological Societies, by A. L. Quaintance, Washington, D. C.

Report of the Committee on Nomenclature, by Edith M. Patch, Orono, Me.

Report of the Committee on Index to Economic Entomology, by E. P. Felt, Albany, N. Y.

Report of the Committee on United States National Museum, by J. J. Davis, Lafayette, Ind.

Report of the Committee on Amendments to the Constitution and By-Laws, by W. P. Flint, Urbana, Ill.

Appointment of Committees.

Miscellaneous Business.

New Business.

Annual Address of the President, A. G. Ruggles, St. Paul, Minnesota.

1. "Pioneering in Economic Entomology."

READING OF PAPERS

2. The Insects Infesting Animal Products in the United States. (10 min.) Perez Simmons, Silver Spring, Md.

3. Further Observations on Tabanidae (Horseflies) in Louisiana. (10 min.) T. H. Jones and W. G. Bradley, Baton Rouge, La.

Adjournment.

Program

Monday Afternoon Session, December 31, 1923, 1:30 p. m.; Chemistry Auditorium

Discussion of the Presidential Address.

READING OF PAPERS

4. The Occurrence of the European Tortricid, *Cacoecia rosana* L. in Canada. (10 min.) Arthur Gibson, Ottawa, Canada.

This European insect has of recent years developed into a pest of importance in several sections of Canada.

5. Factors Affecting Damage to Crops by Insects. (10 min.) (Lantern). R. L. Webster, Fargo, N. D.

A brief statement concerning limiting factors to crop production and their relation to insect injury, with particular reference to deficient rainfall.

6. Temperature as a Limiting Factor in the Life of Subcortical Insects. (15 min.) S. A. Graham, St. Paul, Minn.

7. The Australian Prickly-pear Problem. (15 min.) (Lantern.) J. C. Hamlin, Houston, Texas.

An attempt biologically to control the prickly-pear pest.

8. The Gipsy Moth Problem in New York State. (12 min.) (Lantern.) E. P. Felt, Albany, N. Y.

9. Recent European Investigations of the Parasites of the Gipsy Moth and the Brown-tail Moth. (15 min.) S. S. Crossman and R. T. Webber, Melrose Highlands, Mass.

An account of recent introductions into the United States of parasites of the Gipsy Moth and Brown-tail Moth.

10. The Importation of Parasites to control the Japanese Beetle (*Popillia japonica*). (10 min.) (Lantern). L. B. Smith, Riverton, N. J.

A general summary of the work accomplished and results secured during past season.

11. Selective Parasitism by *Tiphia* sp. (8 min.) H. A. Jaynes and T. R. Gardner, Riverton, N. J.

The result of three years study of the parasitism on *Ochrosidia* (*Cyclocephala*) *immaculata* and *Popillia japonica*, by certain species of Tiphia.

12. Notes on the Life History of a Beneficial Reduviid, *Sinea diadema* (Fabr.). (5 min.) (Lantern). P. A. Readio, Lawrence, Kan.

13. Natural Enemies of Beet Leafhopper (*Eutettix tenella* Baker). Henry H. P. Severin, Berkeley, Calif.

14. Dusting Investigations on Truck Crops in Maryland. (15 min.) (Lantern). E. N. Cory and S. F. Potts, College Park, Md.

A summary of two years work with nicotine dusts on the pea aphis with special reference to the effectiveness of commercial and home mixed dusts, rates per acre and comparison of costs. Summaries of results with other dust mixtures used against the pea aphis.

15. Some Chemicals Attractive to Adults of the Onion Maggot, *Hylemyia antiqua* Meig. and the Seed-Corn Maggot (*Hylemyia cilicrura* Rond.). (15 min.) (Lantern). Alvah Peterson, New Brunswick, N. J.

Several alcohols and other organic chemicals attract males and female flies.

16. Some new aspects of the Bichloride Treatment for Cabbage Maggot Control. (10 min.) Hugh Glasgow, Geneva, N. Y.

Observations on the influence of mercuric chloride on plant growth, and on the development of certain diseases affecting cabbage seedlings.

17. A Stilt-bug, *Jalysus spinosus* Say, Destructive to the Tomato. (10 min.) C. R. Phipps, Mountain Grove, Mo.

Description, injury, life-cycle and control.

Adjournment.

Monday Evening Session, December 31, 1923, 8:00 p. m.; Chemistry Auditorium

MEETING OF THE INSECT PEST SURVEY AND EXTENSION ENTOMOLOGISTS

Program

Tuesday Morning Session, January 1, 1924, 10:00 a. m.; Chemistry Auditorium

18. Methods of Estimating Insect Abundance and Damage. Symposium. (10 minutes each).

Statistical Work in Entomology. J. A. Hyslop, Washington, D. C.

The Use of Biometrical Methods in the Interpretation of Codling Moth Experiments. F. Z. Hartzell, Fredonia, N. Y.

Methods of Estimating Insect Abundance and Damage.

The Gipsy Moth. A. F. Burgess, Melrose Highlands, Mass.
The San Jose Scale. J. J. Davis, Lafayette, Ind.
The Boll Weevil. W. D. Hunter, Houston, Texas.
Grasshoppers. Stewart Lockwood, Billings, Mont.
The Hessian Fly. W. H. Larrimer, West Lafayette, Ind.

Value of Statistical Methods in Entomology. C. L. Marlatt, Washington, D. C.

READING OF PAPERS AND DISCUSSIONS

19. Recent Developments in Greenhouse Fumigation with Hydrocyanic Acid Gas. (10 min.) (Lantern). E. R. Sasscer and C. A. Weigel, Washington, D. C.

Device for dropping cyanid in jars simultaneously in commercial houses. Value of liquefied hyrdocyanic acid gas. Preliminary notes on calcium cyanid. Plant tolerance.

20. Lubricating Oil Emulsion as a Control for *Chrysomphalus aonidum* in Greenhouses. (10 min.) C. A. Weigel and Miss B. M. Broadbent, Washington, D. C.

Results of recent experiments in controlling *Chrysomphalus aonidum* on Kentia palms, Ficus, and other ornamental plants.

21. The Use of Lubricating Oil Emulsions on Greenhouse Scale Insects. (5 min.) C. C. Compton, Aurora, Ill.

22. Oil sprays for the Control of the Winter Eggs of *Paratetranychus pilosus*. (15 min.) (Lantern). C. C. Hamilton, College Park, Md.

23. Four Year Experiments on the Control of the Red Spider (*Paratetranychus pilosus*. (10 min.) S. W. Frost, Arendtsville, Pa.

Dormant and Summer applications with dusts and sprays for the control of Red Spider.

Adjournment.

Program

Tuesday Afternoon Session, January 1, 1924, 1:30 p. m.; Chemistry Auditorium

READING OF PAPERS

24. Control of the Root-Knot Nematode. (15 min.) J. R. Watson, Gainesville, Fla.

25. The Use of Calcium Cyanide Against Fleas and Other Injurious Insect Pests. (10 min.) K. C. Sullivan, Columbia, Mo.

A brief summary of experiments which have been conducted during the past season with calcium cyanide on the control of fleas and melon pests; also some brief notes on its use for fumigating greenhouses and nursery stock.

26. Calcium Cyanide. (10 min.) William Moore, New York, N. Y.

The manufacture, chemical composition and the reactions which makes this compound a promising insecticide.

27. Soil Insecticide Investigations at the Japanese Beetle Laboratory during 1923. (5 min.) B. R. Leach, W. E. Fleming and J. P. Johnson, Riverton, N. J.

28. Insecticidal Properties of Some Sulfur Compounds. (10 min.) Albert Hartzell and F. H. Lathrop, Geneva, N. Y.

The methods of preparation of a Carbon Disulfide Emulsion and its possibilities as a contact insecticide.

29. The Price of Insecticides. (10 min.) V. I. Safro, Clarksville, Tenn.

Elementary economic factors almost universally lost sight of by entomologists in the search for cheaper insecticides.

30. The Japanese Beetle Status in 1923. (10 min.) L. B. Smith. Riverton, N. J.

General summary of spread and results of investigations on the control of this insect in 1923.

31. Some Recent Developments in the Use of Paradichlorobenzene. (10 min.) S. C. Chandler, Carbondale, Ill.

32. Three Years of Paradichlorobenzene Experiments in the South. (10 min.) O. I. Snapp, Fort Valley, Ga.

33. Carbon disulphid for exterminating the Round-headed Apple-tree borer (*Saperda candida*). (10 min.) O. A. Johannsen, Ithaca, N. Y.

The proposed method requires less time than when using the knife; neither mutilates nor injures the tree, andwhen properly used, is 100% efficient.

34. Notes on the Occurrence of the Oriental Fruit Moth (*Laspeyresia molesta*) in Southeastern Pennsylvania in 1923. (3 min.) T. L. Guyton, Harrisburg, Pa.

The appearance of *Laspeyresia molesta* in alarming numbers occurred over the southeastern corner of Pennsylvania. No injury was noticed in this area in 1922.

35. A New Fruit Pest. (10 min.) (Lantern). W. P. Flint, Urbana, Ill.

During the past 3 seasons, apples and peaches in Illinois have been injured by a beetle previously of rare occurrence in the State and not known to feed upon fruit. A brief summary of the character of injury and feeding habits of this beetle.

36. Control of Leaf Hoppers (*Empoa rosae* L.) in bearing orchards. (10 min.) (Lantern). S. W. Frost and E. M. Craighead, Arendtsville, Pa.

A new type of injury to apple by hoppers; control experiments in bearing orchards.

37. Should the July Apple Spray as given in Ohio be timed for the Second Brood only of Codling Worms? (5 min.) (Lantern). H. A. Gossard, Wooster, Ohio.

Relation between the life history of codling worms and time of spraying graphically shown. The chart shows that in Ohio the July spray is given for the first brood as well as the second.

38. A Side Light on Spray Injury to Apple Fruits. (5 min.) (Lantern). P. J. Parrott, Geneva, N. Y.

During recent years there has been growing interest with respect to the effect of spray materials on the quality and size of apple yields. In this paper data are presented relative to the occurrence of "spray burn" following applications of various dust and spray mixtures.

39. Spreader Tests on Apples and Peaches: A Second Report. (8 min.) L. A. Stearns and W. S. Hough, Blacksburg, Va.

Title indicates contents of paper; report covering a second seasons' investigation of casein spreader in orchard practice.

40. The Estimation of Dosage for Contact Dusts. (10 min.) F. Z. Hartzell, Fredonia, N. Y.

41. Spraying Experiments for the Control of the San Jose and other Scales. (10 min.) J. J. Davis, Lafayette, Ind.

Summary of experiments for three years testing dry and liquid lime-sulphur, miscible oils and lubricating oil emulsion for the control of the San Jose, Cottony Maple and Oyster Shell Scales.

42. Further Studies in Prune Root Borer Control in Oregon. (10 min.) F. H. Lathrop and V. M. Trask, Highland, N. Y.

Results of naphthalene whitewash applications and of "P. D. B." treatments.

43 Control measures for the cornfield ant (*Lasius niger americanus*) in Strawberry Beds. A Preliminary Report. (5 min.) W. J. Baerg, Fayetteville, Ark.

The paper is a brief description of the injury caused by the cornfield ant to strawberry plants and a report of the results obtained from the use of various insecticides.

44. The Houghton Gooseberry Aphis, *Myzus houghtonensis* Troop, as a Pest in Ohio. (5 min.) (Lantern). D. M. DeLong and A. A. Mathewson, Columbus, Ohio.

Notes on the life history and economic importance.

Adjournment.

Tuesday Evening Session, January 1, 1924, 7 p. m.

Entomologists Dinner.

Program

Wednesday Morning Session, January 2, 1924, 10:00 a. m.; Chemistry Auditorium

Reading of Papers

45. Certain Dusts as Agents for the Protection of Stored Seeds from Insect Infestation. (15 min.) T. J. Headlee, New Brunswick, N. J.

46. Notes on the Use of Chlorine Gas as an Insecticide. (3 min.) T. L. Guyton, Harrisburg, Pa.

Chlorine Gas was used in an attempt to control *Sitotroga cerealella*. The gas was found to be an imperfect insecticide and to reduce the germination about three-fourths.

Papers on European Corn Borer

47. Research Projects and a Synopsis of Results. (8 min.) D. J. Caffrey, Arlington, Mass.

48. Environmental Studies. (8 min.) K. W. Babcock, Arlington, Mass.

49. Parasite Introductions. (8 min.) D. W. Jones, Arlington, Mass.

50. European Corn Borer Investigations in Ohio. (8 min.) L. L. Huber, Wooster, Ohio.

51. European Corn Borer: Control Measures Recommended in the Province of Ontario. (8 min.) Lawson Caesar, Guelph, Ontario, Canada.

52. Plowing as a Factor in Control. (8 min.) H. G. Crawford, Ottawa, Canada.

53. The European Corn Borer: Clean-up Measures. (8 min.) (Lantern). T. H. Parks, Columbus, Ohio.

54. Quarantines in Canada. (8 min.) L. S. McLaine, Ottawa, Canada.

55. European Corn Borer Quarantine (8 min.) L. H. Worthley, Arlington, Mass.

Adjournment.

Program

Wednesday Afternoon Session, January 2, 1924, 1:30 p.m.; Chemistry Auditorium

Reading of Papers

56. An Asiatic Beetle in Connecticut. *Anomala orientalis* Waterhouse. (10 min.) W, E. Britton, New Haven, Conn.

Specimens of *Anomala* collected in a nursery in New Haven in 1920 and 1921 were identified in May 1922, as *Anomala orientalis*. In 1923, white grubs injured the roots of grass in lawns in the vicinity. Adults were reared and proved to be this species.

57. The biology of *Anomala kansana*. (15 min.) W. P. Hayes and J. W. McColloch, Manhattan, Kan.

The life history, length of stages and importance of this new species is discussed.

58. Grasshopper Baits: With Special Reference to Sodium Arsenite. (12 min.) C. L. Corkins, Laramie, Wyo.

This paper will be a brief of the results of three years experimentation in Colorado.

59. The Time of Planting Corn as a Factor in Corn Earworm Control (10 min.) J. W. McColloch Manhattan, Kan.

60. Importance of the Flax-seed count in determining the Hessian fly free date. (5 min.) C. J. Drake, F. A. Fenton and F. G. Butcher, Ames, Iowa.

61. *Caenurgia erechtea* Cram. (Noctuidae) as an Alfalfa Pest. (7 min.) (Lantern). R. C. Smith, Manhattan, Kan.

One of the lesser alfalfa pests but often abundant in Kansas. The paper is a summary of life history and field observations with description of stages and one plate.

62. New Developments in Alfalfa Weevil Activity and Control. (15 min.) Claude Wakeland, Prama, Idaho.

63. Controlling Chinch Bugs in Missouri with Calcium Cyanide. (15 min.) Leonard Haseman and S. W. Bromley, Columbia, Mo.

Short paper dealing with the methods of controlling chinch bugs with Calcium Cyanide in both an experimental and practical way. Calcium cyanide was successfully used on a rather large scale in Missouri during the past season and it is the intention of this paper to explain briefly its use and the results obtained.

Final Business

Report of Committee on Resolutions.

Report of Committee on Membership.

Reports of other committees.

Nomination of Journal officers by advisory committee.

Report of Committee on Nominations.

Election of Officers.

Miscellaneous business.

Fixing the time and place of next meeting.

Final adjournment.

A. G. Ruggles, *President*,
St. Paul, Minn.

A. F. Burgess, *Secretary*,
Melrose Highlands, Mass.

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VOL. 16 DECEMBER, 1923 No. 6

Proceedings of the Eighth Annual Meeting of the Pacific Slope Branch of the American Association of Economic Entomologists

The eighth annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held in the Y. M. C. A. Hut, University of Southern California, Los Angeles, California, September 17–19, 1923.

The meetings were called to order at 2:30 P. M. by Acting Chairman Roy E. Campbell in the absence of H. J. Quayle. A brief business meeting was held at the opening session, followed by several papers. The symposium idea was largely followed in the discussion of the topics and visits were made to the Nicotine Dust Factory of the California Sprayer Co., Los Angeles; the State Insectary at Whittier; and the Liquid Cyanide Plant at Azusa. One session, Wednesday afternoon, September 19, was a joint meeting with the Pacific Division of the Plant Physiological Section of the Botanical Society of America, the Pacific Division of the American Phytopathological Society, and the Ecological Society of America. The meetings closed with a very enjoyable banquet held at the University Club at Los Angeles, where the chairman, R. E. Campbell, acted as toastmaster.

The largest attendance of any of the western meetings was registered, including the following members and visitors:

A. J. Basinger, Riverside, Cal.
R. Kent Beattie, Washington, D. C.
A. E. Bottel, Riverside, Cal.
J. S. Boyce, Portland, Ore.
A. A. Brock, Santa Paula, Cal.
H. E. Burke, Palo Alto, Cal.
R. E. Campbell, Alhambra, Cal.
Eubanks Carsner, Riverside, Cal.
F. R. Cole, Redlands, Cal.
H. Compere, Whittier, Cal.
J. P. Coy, San Bernardino, Cal.
Clifford T. Dodds, Santa Paula, Cal.
E. O. Essig, Berkeley, Cal.
C. K. Fisher, Alhambra, Cal.
W. E. Fisher, Alhambra, Cal.
S. E. Flanders, Saticoy, Cal.
A. J. Flebut, Lindsay, Cal.
F. H. Gates, Santa Paula, Cal.
R. D. Hartman, Palo Alto, Cal.
Frank B. Herbert, Los Gatos, Cal.

W. B. Herms, Berkeley, Cal.
J. F. Lamiman, Berkeley, Cal.
A. O. Larson, Alhambra, Cal.
Arthur C. Mason, Lindsay, Cal.
A. W. Morrill, Los Angeles, Cal.
L. S. Neville, Los Angeles, Cal.
E. R. deOng, Berkeley, Cal.
E. M. Packard, Sacramento, Cal.
D. D. Penny, Pomona, Cal.
M. E. Phillips, Fresno, Cal.
G. P. Rixford, San Francisco, Cal.
Fred P. Roullard, Fresno, Cal.
M. B. Rounds, Azusa, Cal.
H. T. Ryan, Los Angeles, Cal.
E. A. Schwing, Spreckels, Cal.
Henry H. P. Severin, Berkeley, Cal.
H. S. Smith, Riverside, Cal.
L. B. Soliman, Berkeley, Cal.
C. F. Stahl, Riverside, Cal.
H. E. Summers, Los Angeles, Cal.
W. B. Turner, Sacramento, Cal.
Theodore D. Urbans, Sacramento, Cal.
W. H. Volck, Watsonville, Cal.
Geo. P. Weldon, Ontario, Cal.
R. S. Woglum, Los Angeles, Cal.
K. L. Wolff, Los Angeles, Cal.
H. E. Woodworth, Berkeley, Cal.
W. S. Wright, San Diego, Cal.
F. H. Wymere, Berkeley, Cal.

PART I. BUSINESS SESSION

The business meeting was called to order by Acting Chairman R. E. Campbell at 2:30 P. M.

The first order of business was the report of the Secretary-Treasurer which was as follows:

REPORT OF THE SECRETARY-TREASURER
FINANCIAL STATEMENT

1923				
February 1.	On hand			$24.60
(1) March 29	Paid affiliation fee to Amer. Assn. Adv. Sci		$5.00	
(2) April 18	Paid for notices to members to Armstrong School		6.10	
	Stamped envelopes	$2.55		
	1 stencil	.20		
	24 lines @$.03	.72		
	125 copies	1.15		
	Addressing	.63		
	Stamping, folding, sealing	.85		
		$6.10		
(3) August 23	Paid for notices to members to Armstrong School		$4.70	
	110 stamped envelopes	$1.40		
	25 lines @$.05	1.25		
	Running 120 copies	1.00		
	Addressing and mailing	1.05		
		$4.70		
August 23	Total disbursements		$15.80	$24.60
August 23	Amount on hand			$8.80
March 29	Received interest			.52
August 23	Received interest			.44
September 1	On hand			9.76
September 1	Refund due from Amer. Assn. Econ. Ent		$15.80	

The following committees were then appointed by the Chairman:

Affiliation: W. B. Herms, Chairman, E. P. Van Duzee.

Nomination: E. O. Essig, Chairman, H. E. Burke, C. F. Stahl.

Auditing: H. E. Woodworth, Chairman, D. D. Penny.

Resolutions: E. M. Packard, Chairman, Henry H. P. Severin.

Membership: H. E. Burke, three years; C. W. Creel, two years; E. C. Van Dyke, one year.

It was then proposed that the office of Vice-chairman be included among the new nominations. Upon motion, this was duly carried.

The question of membership then followed concerning associate and active standings, there being considerable opposition to the associate standing because so many were never moved up into active membership as they should be.

The matter of publishing papers was then presented and discussions brought out the many difficulties that members experience in trying to get their papers published in the official journal of the society. The discussion resulted in a motion by H. S. Smith "that it be the sense of the meeting that the JOURNAL OF ECONOMIC ENTOMOLOGY be changed to a monthly and the subscription price made according." The motion was seconded by H. E. Burke and carried unanimously. The matter was then referred to the resolutions committee.

The meeting was adjourned for 15 minutes to allow the committees to formulate their reports and called to order at 4 P. M. by the chair. The reports of the committees were as follows:

NOMINATIONS

For Chairman, H. S. Smith, Riverside, Cal.

For Vice-Chairman, C. M. Packard, Sacramento, Cal.

For Secretary-Treasurer, R. E. Campbell, Alhambra, Cal.

Upon motion duly seconded the secretary was instructed to cast the ballot for the election of the nominees. Carried.

The auditing committee reported the accounts in accordance with the statement of the treasurer.

The resolutions committee offered two resolutions as follows:

Resolved: That it is the sense of this meeting that the increase in volume of publication warrants an increase in the capacity of the Journal of Economic Entomology by changing it to a monthly, and that any increased expense involved be met by increasing the subscription price.

Resolved: That a vote of thanks be extended to the University of Southern California for their hospitality in providing the Pacific Slope Branch of the American Association of Economic Entomologists with a meeting place and that the secretary forward a copy of this resolution to the University.

Both resolutions were adopted upon motions duly made, seconded and carried.

PART II. PAPERS AND DISCUSSIONS

Afternoon Session, September 17, 1923

Following the adjournment of the business session Chairman R. E. Campbell opened the regular session and called for the first paper. It was presented by Mr. Stahl as follows:

A DISCUSSION OF *EUTETTIX TENELLA* BAKER AS A CARRIER OF CURLY-TOP OF SUGAR BEETS

By C. F. STAHL, *Assistant Entomologist, Bureau of Entomology*, and EUBANKS CARSNER, *Pathologist, Bureau of Plant Industry.*

ABSTRACT

Eutettix tenella when feeding, has the ability under certain conditions to produce a systemic disease, known as curly-top in the sugar beet. This ability is acquired by the insect after emerging from the egg as a result of feeding for only a short period upon a plant already diseased. After this feeding some time must elapse before the insect is able to transmit the virus to a healthy plant. This fact indicates that there may be a short incubation period for the virus in the insect. When once the ability to produce the disease is acquired there is no evidence to indicate that it is ever lost during the life of the insect. Although many insects of species other than *Eutettix tenella* have been experimented with, not one has been found that is able to transmit the virus of curly-top.

Since the announcement by Dr. E. D. Ball in 1906[1] that the beet leafhopper (*Eutettix tenella* Baker) was responsible for the disease of sugar beets known as curly-top, the problem has been the subject of practically continuous investigation. As a result of these studies, many interesting and important data concerning the relation of the insect to the disease have been obtained and reported, but up to the present time the nature of the causative agent has not been learned.

Many of the ascertained points concerning the insect and its function in transmitting the disease are suggestive and as they may be of assistance in future work conducted for the purpose of determining the causative agent for the disease, it is deemed desirable to bring together in a brief discussion some of the more important facts relating to this phase of the problem.

This jassid which inhabits the arid and semi-arid regions of the West, shows some preference for plants of the family Chenopodiaceae, and produces under certain conditions in the sugar beet a systemic disease, curly-top. Available evidence indicates that curly-top has been present in sugar beet fields in the districts inhabited by this insect from the time the beets were first planted there. This crop appears to have been selected by the insect because the plants are suitable for oviposition and food.

The ability to transmit curly-top is acquired by the insect after it has

[1] 16th Ann. Rept. Agr. Coll. Utah Exp. Sta. for 1905, p. XVI.

emerged from the egg; this has been demonstrated experimentally in the laboratory as well as by field observations. Nymphs which were removed immediately after hatching from diseased plants and before they had fed on them, were placed on healthy plants and in no case were they able to produce the disease. After feeding on an infected plant, however, they were able to transmit the disorder. Important additional evidence bearing on this phase has been obtained in the field. It is often possible to find in cultivated areas and in beet fields in the spring large numbers of adults of this insect which will not produce the disease. Fields heavily infested by this jassid have been noted in which the disease was either absent or present only in scattered cases. These facts suggest strongly that the leafhopper is normally unable to produce the malady and that there must be a source, continuous from year to year, from which the virus can be obtained.

No evidence has yet been gained to support a theory that this acquired ability is of any advantage to the insect.

When a nonviriferous insect, i. e., one which does not carry the virus, is allowed to feed upon a plant affected with curly-top, in our experiments it invariably becomes able to transmit the disease to healthy plants. The length of the feeding period required for the insect to obtain the virus is evidently very short. Reports regarding this point vary, intervals as short as one or two minutes having been indicated as sufficient in some instances. The writers have produced curly-top in healthy plants with insects which had fed on diseased plants for 10 minutes only.

After feeding, a short interval apparently must elapse before the virus can be transmitted to a healthy plant and produce disease, four to six hours under high temperatures having been reported. The writers have been able to secure such a transmission of the disease by means of *Eutettix tenella* within a period of 15 hours after the insect had fed on a diseased beet plant. It has been noted that at least for a certain period, a higher percentage of insects is able to produce the disease as the length of the interval between feeding and inoculation increases. The increase in number is greatest during the interval between 24 and 72 hours. The evidence available at the present time, therefore, indicates that the transmission is not mechanical, that is, simply by the contamination of the mouthparts.

When the insect is able to transmit the virus of curly-top, only a short feeding period on the healthy plant is necessary. A period of 5 minutes has been reported as sufficient for transmission but the minimum

period noted by the writers has been 20 minute for sugar beets and 10 minutes for chickweed (*Stellaria media*). This indicates that only a small amount of virus may produce a typical case of curly-top. It has been reported that the larger the number of leafhoppers feeding on a plant, the more rapid the development of the disease. This statement is contrary to the experience of the writers who have demonstrated many times that a single individual of this species, either nymph or adult, will not only produce as serious a case of curly-top as will a large number on a single plant, but also there is no difference in the rate of development of the disease.

When once the insect is able to produce the disease, this ability is apparently never lost. Evidence to support this statement has been obtained by keeping individuals known to be viriferous on plants from which the virus has never been obtained and determining from time to time whether or not they were capable of producing the disease. In view of this finding, it is probable that hibernating adults might retain the ability of the virus transmission throughout the winter. This point, however, has not been tested by the writers. It is also known that nymphs do not lose the disease-producing ability during the molting process. There is apparently no evidence to support the theory that the nymph is more virulent than the adult.

An interesting fact encountered in the problem is the apparent inability of any species other than *Eutettix tenella* to transmit the disease. Although this possibility has been assumed for a number of years, little mention has been made of it in the literature. The writers have tested several species of insects from time to time and during the past season tests have been conducted with species commonly collected on sugar beets and related plants. In all cases the insects were forced to feed for some time on beets badly affected with curly-top. From these diseased plants they were transferred to young healthy beet plants growing under conditions especially favorable for the development of the disease. From one to five individuals were confined on a plant. These tests are still in progress but thus far all results have been negative.

The following is a partial list of the species tested:

Species Tested	No. tested
Cicadula sexnotata Fall	17
Lygus pratensis L	12
Nysius sp	10
Systena taeniata Say	6
Eutettix strobi Fitch	6
Thamnotettix montanus Van D	5
Thamnotettix geminatus Van D	6

Empoasca sp. 60
Agallia spp. 71

Undetermined aphids found on diseased beets have been transferred to healthy plants on many occasions but without producing the disease. If, as now appears, no species of insect other than *Eutettix tenella* can transmit curly-top, some explanation of the peculiar adaptation in this case should be sought by further investigation.

The paper was then discussed by Mr. E. Carsner, H. H. P. Severin, C. F. Stahl and other members.

Chairman R. E. CAMPBELL then called for the next paper on the program.

INVESTIGATIONS OF BEET LEAFHOPPER (*EUTETTIX TENELLA* BAKER) IN SALINAS VALLEY OF CALIFORNIA

By HENRY H. P. SEVERIN, Ph.D., *California Agricultural Experiment Station.*

ABSTRACT

The multiplication of the beet leafhopper (*Eutettix tenella* Baker) in the Salinas Valley occurs chiefly on sugar beets. The nymphs were bred from eggs deposited in seventeen weeds growing in the cultivated areas. There was no evidence to show that a migration occurs from the San Joaquin into the Salinas Valley through the Coalinga-King City mountain pass. During the autumn dispersal the overwintering adults fly to the foothills, following the Salinas River and its tributaries.

Early planting of sugar beets (December to February) is the only known practical method of preventing losses from curly leaf in localities outside of the fog belt. In the fog belt districts late planted beets make a better tonnage than early plantings in a normal season of rainfall. Planting should be discontinued from March 1, until after the spring dispersal. The limit of beet growing in the fog belt as far as curly leaf is concerned varies from 20 to 30 miles in California.

I. LOCATION AND BOUNDARIES

The Salinas Valley is the largest of the many valleys inclosed within the Coast Range in California. From Monterey Bay it extends in a southeasterly direction, in a line parallel with the coast, to its head—a distance of about 100 miles. Its average width is from 7 to 9 miles. Upon the northwest the valley is bounded by Monterey Bay; upon its sides by the Sierra Santa Lucia and Sierra Salinas ranges, with their outlying spurs upon the west; and by the Gabilan and Mount Diablo ranges upon the east, the latter separating the Salinas Valley from the San Joaquin Valley of the interior of the State.

II. INTRODUCTION

Ball (1) believes that the beet leafhopper migrates from the San Joaquin into the Salinas Valley. He found the leafhoppers "breeding in abundance on the native Atriplex in the Tulare region. This district

extends down as far as Bakersfield . . . . . In the Salinas Valley, King City is the nearest beet growing point to this region, and is in direct line of air drainage between Monterey Bay and the low pass over into the interior."

According to Ball (1) "curly leaf rarely appears in the region along the coast, where fogs are prevalent, but as one passes to the interior points it becomes more frequent and seems to be somewhat proportional to the temperature encountered . . . . Except in periods of abundance the beet leafhopper is not found in the region along the coast from San Francisco south to the Mexican border."

III. Favorable Breeding Plants in Cultivated Areas

In the Salinas Valley annual saltbushes are scarce and the multiplication of the pest occurs chiefly on sugar beets. The beet leafhopper has been bred from the following plants growing in the cultivated areas of the valley:

Plants in Which Beet Leafhopper Deposited Eggs in Cultivated Areas of Salinas Valley.

Chenopodiaceae.

Annual Saltbushes.

1. Silverscale or Fog Weed (*Atriplex argentea*). Native.
2. Bractscale (*Atriplex bracteosa*). Native.
3. Redscale or Red Orache (*Atriplex rosea*). Introduced from Europe.

Perennial Saltbushes.

4. Australian Saltbush (*Atriplex semibaccata*). Introduced from Australia.

Pigweeds.

5. Pigweed or Lamb's Quarters (*Chenopodium album*). Common European weed.
6. Nettle Leaf Goosefoot (*Chenopodium murale*). Naturalized from Europe.

Weeds.

7. Russian Thistle (*Salsola kali tenuifolia*). Introduced from Asia.

Plants From Other Families

8. Curly Dock (*Rumex crispus*). Naturalized from Europe.
9. Rough Pigweed (*Amaranthus retroflexus*). Introduced from tropical America.
10. Tumble Weed (*Amaranthus graecizans*). Naturalized from tropical America.
11. *Amaranthus deflexus*. Introduced from southern Europe.
12. Wild Radish (*Raphanus sativus*). Naturalized from Europe.
13. Chinese Pusley (*Heliotropium curassavicum*). Widely distributed in the East and in South America and the Old World.
14. Common Horehound (*Marrubium vulgare*). Naturalized from Europe.
15. Tolguacha or Jimson Weed (*Datura meteloides*). Texas to California and adjacent Mexico.
16. Black Nightshade (*Solanum nigrum douglasii*). Native of Europe.
17. Spiny Clothbur (*Xanthium spinosum*). Native of Europe? Naturalized from Tropical America? Introduced from Chili?

IV. Spring Dispersal

During the period 1918–1923, investigations in the Gabilan and Mount Diablo ranges conducted by Mr. W. W. Thomas, Mr. E. A. Schwing and the writer, have failed to show any evidence, whatsoever, that a

migration of the beet leafhopper occurs from the San Joaquin Valley into the Salinas Valley through the Coalinga-King City mountain pass. There was no evidence to show that an enormous congregation of the insects occurs on the east side of this mountain pass during the spring. Wherever annual saltbushes grow in the mountain passes along roadsides, or covering alkali sinks, leafhoppers may be taken, which congregated on these plants after the pasture vegetation became dry on the foothills. The general distribution of the hoppers on annual Atriplexes in the mountain passes indicates that these insects have a keen sense of smell. Those leafhoppers which assemble on favorable food and breeding plants during the spring flights remain in the cultivated foothill regions together with the later summer generations.

During the period 1918–1921, the first appearance of the pale green spring brood adults in the cultivated areas of the Salinas and San Joaquin Valley occurred as follows:

Salinas Valley	San Joaquin Valley
1918 May 8, King City	1918 April 24, upper.
1919 April 22, King City	1919 April 8, 14, 28, upper, middle, lower.
1920 April 22 or 23, King City	1920 April 23, upper.
1921 April 25 to 30, King City	1921 April 6, 14, upper, middle.

V. Autumn Dispersal

During 1918, the first indication of an autumn dispersal of the dark overwintering adults occurred on October 11 to 13, in a mountain pass at Bitterwater about 15 miles northeast of King City. The insects had left the dried Redscale or Red Orache but some of the hoppers were still present on partly green Silverscale or Fog Weed growing in a large alkali sink. A congregation of adults had occurred on green pasture vegetation growing at the base of the foothills adjacent to the alkali sink. The movement of the dark overwintering adults from the alkali sink was not toward the San Joaquin Valley but in the opposite direction.

During the autumn dispersal in the Salinas Valley the dark overwintering adults were rarely taken on Red Stem Filaree (*Erodium cicutarium*) growing on the foothills within the fog belt. The leafhoppers, however, were captured more abundantly outside of the fog belt between Greenfield and King City and were far more numerous on the northeastern than on the southwestern foothills of the Gabilan and Sierra Santa Lucia ranges respectively.

During the autumn of 1919, large numbers of dark overwintering adults disappeared from the experimental field at King City on November 21. After the beets are topped large numbers of nymphs probably succumb in a dry autumn unless they are able to obtain food from

green plants growing along irrigation and drainage canals and roadsides.

During October and November 1920, Mr. E. A. Schwing discovered the dark overwintering adults on perennials growing along the Salinas River and its tributaries flowing from the Coast Range. As soon as the pasture vegetation germinated most of the leafhoppers left the perennials and were found on Red Stem Filaree growing on the foothills.

During the autumn of 1921, Schwing and the writer again found the dark overwintering adults commonly on perennials growing along the stream-ways of the Salinas River and its tributaries. In the fog belt leafhoppers were rarely taken on perennials but in the interior specimens were commonly captured on Creek Senecio (*Senecio douglasii*) and *Lepidospartum squamatum*. During the morning the bugs were sluggish and inactive and some were found below the bushes on the sand among the roots, fallen twigs and leaves. At sunset a few specimens were attracted to the wind-shield of the automobile and mating was observed. Wherever the two species of perennials were swept with an insect-net from the entrance to about 10 miles up some of the canyons, the hoppers were obtained.

VI. Curly Leaf

After the autumn dispersal of the dark overwintering adults to the foothills has occurred, the cultivated areas are not entirely free from beet leafhoppers during the winter, and these stragglers when abundant are a serious menace to early planted sugar beets. During 1918, heavy September rains fell in the Salinas Valley germinating the seeds of the pasture vegetation on the foothills and a new growth of vegetation developed in the cultivated regions. During November and December, nymphs were taken on vegetation growing along roadsides adjacent to fields in which beets had been harvested. Nymphs which hatched from eggs deposited by the summer brood adults in Red Stem Filaree were also taken on the foothills at King City. These nymphs acquired the winged stage after the autumn flights had occurred and the adults invaded the early planted beet fields adjacent to the foothills. In the upper Salinas Valley over one-half of the crop showed curly leaf symptoms before the spring brood flew into the beet fields on April 22 or 23, 1919. During a dry autumn when annual plants are mostly dry along roadsides, the number of nymphs can be greatly reduced by removing green vegetation along irrigation and drainage canals in beet fields.

VII. Early Planting of Sugar Beets Outside of Fog Belt

Early planting of sugar beets is the only known practical method of

preventing serious losses from curly leaf in localities outside of the fog belt. The fact that the adults leave the cultivated areas in the autumn has an important bearing with reference to the time of planting beets. In a dry autumn it is necessary to pre-irrigate the soil. In the Salinas Valley the adobe soil becomes very sticky when wet, and it is practically impossible to work the soil after the rainy season begins. Beets should not be planted until the end of November outside of the fog belt between Soledad and King City.

VIII. Fog Belt

Ball (1) in discussing the time of appearance of swarms of beet leafhoppers states that flights have occurred in the Salinas Valley "at different seasons and apparently in some instances at different times in the same season." During the past six years large numbers of spring brood adults invaded the fog belt of the Salinas Valley during 1919, 1921 and 1922. The leafhoppers were distributed in all beet districts of the valley on the dates given under spring dispersal. The spring invasion of the first brood into the fog belt probably depends upon the absence of fog at dusk when the flights occur. During 1918, 1920 and 1923, the fog belt was not entirely free from leafhoppers, although greatly reduced in numbers.

IX. Late Planting of Sugar Beets in Fog Belt

According to Schwing and Hartung (2), "in the fog belt districts more leafhoppers were present and a higher percentage of curly leaf occurred in early planted beet fields than in fields planted after the invasion of the pest had occurred in the Salinas Valley." At Santa Rita, about eight miles from the Pacific Ocean, 60 per cent of the early planted beets were blighted compared with 3 per cent in an area replanted on account of the disease in the same field. March plantings showed 80 per cent curly leaf on July 23, near Chualar, about 20 miles from the ocean, while beet seeds which germinated after May 1, showed only 3 per cent blight on August 5. The same condition occurred in the San Juan Valley; where, on one side of the river, March and April plantings were destroyed by curly leaf; while, on the opposite side of the river, late plantings produced a good crop.

It is evident that the date of planting has been the cause of curly leaf trouble in the fog belt of the Salinas Valley. Planting should be discontinued from March 1, until after the spring dispersal from Gonzales to Monterey Bay. In the fog belt from Chualar to Monterey Bay the soil is usually too wet and the weather too cold and foggy to plant early.

A few quotations from Ball (1) with reference to the absence of curly leaf in late plantings in the fog belt in connection with past outbreaks of the beet leafhopper corroborate the same fact observed in 1921. In 1906, "a planting made late in May did not blight while others did ....." In 1906, "plantings made May 22 and 31, at Soledad and June 3, at Spreckles did not show much blight while all earlier ones in these localities did."

The question has repeatedly been asked, why is it that late planted beets made a better tonnage than early plantings in the fog belt. The answer to this question involves the proper interpretation of some of the facts concerning the life history of the beet leafhopper. In the fog belt of the Salinas Valley, Stahl's (3) "experiments conducted at Spreckels, California, demonstrated that there were unquestionably two generations annually in that locality." When the pale green spring brood adults invade the cultivated areas, most of the specimens were found to be females. There are no flights associated with mating in the beet fields as the pairing of the sexes occurs on the foothills where most of the males remain and die. In the beet fields the females at the egg-laying stage make short flights for the purpose of disseminating the eggs. It is these females of the first generation and the nymphs of the second brood which cause a high percentage of curly leaf in March and April plantings in the fog belt.

Investigations conducted in the fog belt of San Luis Obispo, Santa Barbara, Ventura, Los Angeles and Orange counties, showed that the second brood was greatly reduced in numbers when compared with the first generation. During the serious 1919 outbreak of the beet leafhopper a letter dated September 10, was received stating that swarms of hoppers were flying from beets when disturbed by the beet puller and another report that the horses became covered with leafhoppers during the harvesting of the crop in the fog belt of San Luis Obispo and Santa Barbara counties. These reports were not exaggerated but the leafhopper proved to be *Empoasca viridescens*. A week was spent in estimating the percentages of curly leaf in all of the beet fields and from 6 to 92 per cent of the beets showed curly leaf symptoms. The beet leafhopper was extremely scarce, however, in fact, in most of the fields within the fog belt it was impossible to find a single specimen. The percentage of curly leaf was entirely out of proportion to the number of *E. tenella* present on September 19 to 25. It was found in the fog belt of these two counties that the adults had succumbed to a fungus disease. An examination of the lower surface of the leaves of a single sugar beet

showed 178 dead Jassids, including the beet leafhopper, which had died as a result of a fungus disease. In regions outside of the fog belt, however, no dead fungus diseased insects were found, and near Los Alomos, nymphs and adults were abundant in the badly blighted beet fields.

In the Salinas Valley, no dead fungus diseased leafhoppers have been found in the fog belt and there are other factors which reduce the numbers of the second generation. The summer brood hoppers, however, gradually increase in numbers toward Gonzales, situated near the limit of the fog belt. In Berkeley it was frequently observed that nymphs upon hatching out-of-doors in cages failed to extricate themselves from the eggs and died in a day or two. A high mortality of the nymphs occurs in the fog belt of California, depending upon the distance from the ocean. The nymphs of the second brood do not acquire the winged stage until autumn. Movements associated with mating of the second generation occur at a time when the beets are large enough to withstand the attacks of the leafhoppers. Such factors as a late developing second brood and this generation greatly reduced in numbers, make it possible to grow a crop of beets in the fog belt of the Salinas Valley when planting is delayed until after the spring dispersal of the beet leafhoppers has occurred. The limit of beet growing in the fog belt as far as curly leaf is concerned varies from 20 to 30 miles in California.

X. Bibliography

1. Ball, E. D., 1917. The Beet Leafhopper and the Curly Leaf Disease that It Transmits. Utah Agr. Exp. Sta., Bul. 155, pp. 1–56.
2. Schwing, E. A. and Hartung, W. J., 1922. Utilization of Systematic Observations on Beet Leafhopper (*Eutettix tenella* Baker) and Curly Leaf of Sugar Beets. Jour. Econ. Ent. XV, No. 5, pp. 365–368.
3. Stahl, C. F., 1920. Studies on the Life History and Habits of the Beet Leafhopper. Jour. Agr. Res. XX, No. 4, pp. 245–252.

The papers were fully discussed by the author, C. F. Stahl, E. Carsner and many of the members.

Following announcements concerning the excursion on Tuesday afternoon and the banquet on Wednesday night, the chairman adjourned the meeting until the following morning.

Morning Session, September 18, 1923

The meeting was called to order by Acting chairman R. E. Campbell who announced that because of the serious fire in Berkeley many of the Berkeley delegates, including the secretary, had returned to Berkeley on the night train.

Mr. A. O. Larson was elected temporary secretary and furnished the following reports.

Chairman R. E. CAMPBELL announced that there would be a dinner for the members and an excursion to the plants of the California Sprayer Co., Los Angeles, and the American Cyanamid Co. at Azusa, and also to the State Insectary at Whittier.

Chairman R. E. CAMPBELL: We will now take up the regular program of the day, beginning with the symposium on dusting. The first paper is by Mr. E. R. deOng who has returned to Berkeley. It will be read by Mr. J. F. Lamiman.

THE RELATION BETWEEN THE VOLATILITY AND TOXICITY OF NICOTINE IN SPRAYS AND DUSTS

By E. R. DEONG, *University of California*

ABSTRACT

Free nicotine is very volatile, while nicotine sulfate is nonvolatile. The toxicity of nicotine solutions varies in proportion to their conversion from the salt form to the free alkaloid. The volatilization curve of nicotine is almost an exact parallel of the curve of toxicity both of fumigation and spraying. Dust carriers follow this same law, i. e., an inert material does not free the nicotine as does an active carrier and, hence, is less efficient.

The efficiency of nicotine sulfate sprays frequently shows marked variation especially when combined with different types of spreaders. We now know that the alkalinity of the water used as a carrier has a great influence on the value of the spray. Such differences must be even more marked when dust carriers are substituted for water, because of the extreme variability of the chemical nature and the physical action of the dusts used as carriers.

Nicotine in the free state (levorotatory) is readily volatilized and is much more toxic in this stage than when combined with acids (dextrorotatory) to form non-volatile salts. Hence, the commercial forms of nicotine sulfate are much less toxic than when the alkaloid is freed from the combining acid. Death from nicotine poisoning is the result of a fumigating action, the curve of which is very close to that from spraying as will be shown later. This is in harmony with the work of McIndoo, Thatcher and others and goes to prove that nicotine is a tracheal or "respiratory" insecticide rather than a true contact spray. Exceptions to this are found in the treatment of caterpillars where nicotine may be ingested by the mouth.

Commercial applications of the less toxic form of nicotine sulfate are usually made on the assumption, providing any thought is given to it at all, that the water used as a carrier was sufficiently alkaline to free

the nicotine from the combining acid. The addition of soap, ostensibly as a spreader, has a double value for besides its film-forming value, it increases the alkalinity of the solution. In our experimental work, however, it was found that tap water, slightly above the average of hardness and requiring 1.3 cc. of n/50 sulfuric acid to neutralize 100 cc., did not give the fullest toxicity possible even with the addition of soap. An increase in efficiency of from twenty to forty percent occurred in solutions where sufficient alkali was added over those which were neutral. Such results were secured both in spraying and fumigating and in volatilizing experiments.

Experimental

Nicotine solutions, made with free nicotine and with nicotine sulfate with varying degrees of alkalinity and in tap water, were compared in three ways: (1) Rate of volatilization as a film on leaf surfaces and from solutions, (2) Efficiency as a spray on aphids, (3) Efficiency as a fumigant on aphids.

Volatilization Experiments. The nicotine solutions used in this as well as in the spraying and fumigating experiments were, with the

Table I. Foliage Tests of the Volatility of Nicotine in Various Alkaline Solutions and Under Contrasting Meteorological Conditions

A. Laboratory Tests in clear weather.
B. Laboratory Tests in cloudy, rainy weather.
Series (1) Nicotine residue determined after three hours.
Series (2) Nicotine residue determined after twenty-four hours.
Series (3) Nicotine residue determined after forty-eight hours.

No.	Type of Solution	*Percent of Nicotine Recovered*		
		Ser. (1)	Ser. (2)	Ser. (3)
A	Clear weather			
1	Nicotine sulfate, no alkali	48.5	29.9	trace
2	Nicotine sulfate+.25 cc. n/1 NaOH	50.0	25.1	4.8
3	Nicotine sulfate+.5 cc. n/1 NaOH	42.7	13.7	trace
4	Nicotine sulfate in tap water	51.5	15.7	trace
5	Nicotine sulfate in tap water plus soap equal to 4 lbs per 100 gallons	36.6	8.9	3.0
6	Nicotine sulfate+.75 cc. n/1 NaOH	27.9	trace	trace
7	Nicotine sulfate+1.0 cc. n/1 NaOH	10.4	trace	0
8	Free nicotine+.013 gm. Na_2SO_4	14.1	0	0
B	Cloudy and rainy weather			
1	Descriptive matter as above	82.6	46.1	13.4
2		52.7	18.5	7.0
3		26.9	7.7	6.0
4		35.8	12.5	19.0
5		33.2	7.4	0
6		15.5	trace	trace
7		17.9	0	trace
8		41.9	trace	2.7

exception of number 2, a nicotine sulfate solution made in the laboratory from pure nicotine combined with standard sulfuric acid to neutrality with phenolred. One cc. of this solution equaled .166 gm. nicotine. Number 1 was a neutral solution of nicotine sulfate in distilled water. Numbers 2, 3, 6 and 8 were four graduations of the necessary amount of alkali necessary to equalize the combining acid. Numbers 4 and 5 are the same as number 1 except in the use of tap water and of soap. One and two-tenths cc. of each solution were made up to 5 cc. and applied with an atomizer to a large leaf, and after definite periods of time the remaining nicotine was washed off and the amount determined. The final test was made in an open laboratory, where the air had free circulation but where precipitation during the experiment could not wash off the nicotine. The leaves while fresh were suspended from a cord and the spray applied to the surface. Field tests on living plants gave similar results to these but attempts to get comparative data with low and high humidity were impractical on account of slight precipitation.

The data[1] on volatilization are given in Table I, in which will be found a comparison of the loss of nicotine in clear weather with a low humidity and rainy weather with high relative humidity. From this data, it will be seen that there is a marked difference between the volatility rate in clear and rainy weather. This is due in part to the slower evaporation rate of water during high atmospheric humidity, thus holding the nicotine longer in solution and hindering its volatilization. It is also possible that nicotine volatilizes more rapidly from the dry film in low atmospheric humidity. The difference in volatility between free (levorotatory) nicotine and the salt form (dextrorotatory) is very marked. The former after 24 hours has volatilized to the extent that only traces are found even by very delicate chemical tests, the range of recovery for the latter being from 29.9 to 46.1 per cent. This proves that the full amount of nicotine from a properly made spray is released in 24 hours and that from 85 to 90 per cent is available in the first three hours during clear weather, while the alkaloid combined with an acid may lack from 13 to 19 per cent of being volatilized after 48 hours of cloudy weather. Such long periods required for activation necessarily reduce the efficiency of a spray in two ways: the concentration of nicotine released may not be high enough at any one time to become

[1]All nicotine determinations were made by the silicotungstic acid method as reported by Chapin, U. S. Department of Agriculture, Bureau of Animal Industry, Bul. 133.

toxic, or rain may wash off an application or dilute it to a point of inefficiency.

It should be noted that a reduction in the amount of nicotine in solutions recovered from sprayed leaves is not necessarily due alone to volatilization but probably includes oxidation into other compounds. Nicotine oxidizes readily, turning brown when exposed to air. Under the action of oxidizing agents it yields a different product. The oxidation of nicotine seems to occur only when exposed to large quantities of air or over a considerable period of time. For example, in aspirating two to four hundred liters of air through a nicotine solution, and where the volatile nicotine passed through two or three feet of rubber tubing, it was only in rare cases that even a trace of nicotine was recovered in the washing liquid, but a close correlation was found between the amount of volatile nicotine recovered with damp silicotungstic paper, at the top of the tube, and that remaining in solution at the bottom of a short, closed, glass tube. This shows that the nicotine from a dust or spray that is in close proximity to the body of an insect would enter the tracheae unchanged but as the nicotine dissipates in the air it is soon oxidized.

Spraying Experiments. Nicotine solutions with varying alkalinity were used as in Table I., but at dilutions of one to one thousand. This concentration was chosen rather than a stronger one as complete mortality was not desired in any of the experiments. Concentration of one to eight hundred gave one hundred per cent efficiency on certain species of aphids with numbers 7 and 8. A neutral solution of nicotine sulfate was used which had been prepared in the laboratory as was also the free nicotine used in number 8. The latter contained an amount of sodium sulfate equivalent to that formed in number 7 by the addition of the neutralizing sodium hydroxide. Distilled water was used in all cases except as noted. The spray was applied by means of an atomizer. Two counts were found necessary as a twenty-four-hour exposure did not give the full effect of the nicotine.

A close correlation is noted in the percentage of mortality between those containing free nicotine (numbers 7 and 8), the latter by reason of the neutralizing alkali added. The lowest efficiency was noted in the nicotine sulfate (dextrorotatory nicotine) solution, thus proving that volatility is a primary factor in the toxicity of nicotine. The results in numbers 4 and 5 show the danger of depending entirely on natural alkalinity or the variable amount found in soap, for releasing all the nicotine.

FUMIGATION EXPERIMENTS. The same solutions were used in this as in the spraying tests, the difference being alone in the method of application. Five cc. of each solution were placed at the bottom of a glass cylinder one and one-half inches in diameter and six inches high. Infested leaves were placed inside the upper end of the cylinder, about four inches from the solution. The upper end of the cylinder was then closed with a cork. Exposure was for the same length of time as in spraying. The data given in Table II show a close correlation between the effect of spraying and fumigating,—further proof of the relation between volatility and toxicity, and also that nicotine is a tracheal rather than a true contact insecticide.

TABLE II. TOXICITY TO APHIDS[2] FROM SPRAYING AND FROM FUMIGATING WITH NICOTINE SULFATE IN SOLUTIONS OF VARYING ALKALINITY

No.	p H value	Nature of Solution	*Percent. of Aphids dead*	
			Spraying	Fumigation
1	6.5	Nicotine as sulfate, 1–1000, distilled water	53.6	48.1
2	6.7	Nicotine as sulfate, 1–1000 plus 2.4 cc. n/1 NaOH, in distilled water	49.7	55.5
3	7.2	Nicotine as sulfate, 1–1000 plus 4.8 cc. n/1 NaOH, in distilled water	60.9	58.9
4	7.4	Nicotine as sulfate, 1–1000 in tap water	51.0	62.9
5	7.6	Nicotine as sulfate, 1–1000 in tap water plus soap at the rate of 4 lbs per 100 gals.	65.3	66.6
6	7.8	Nicotine as sulfate, 1–1000 plus 7.2 cc. n/1 NaOH, in distilled water	65.4	88.4
7	7.9	Nicotine (free) 1–1000, plus an amount of sodium sulfate equivalent to that formed in No. 6, in distilled water	74.6	82.9
8	8.2	Nicotine as sulfate, 1–1000 plus 9.6 cc. n/1 NaOH, in distilled water	76.5	75.7
Check		Untreated aphids	7.7	22.3

[2]Ivy aphid (*Aphis hederae* Kalt.). Green peach aphid (*Rhopalosiphum persicae* Sulzer).

SUMMARY. The graph shows the similarity between the loss of nicotine as determined chemically in the volatilization tests and the bio-assays in fumigating and spraying experiments. These curves are averages of from two to four series, where the same type of solutions have been tested in slightly different ways or on different species of aphids. Larger series would show more regularity in the curves but sufficient work has been done to prove the correlation between volatility and toxicity. This also shows the value of a slight addition of alkali to solutions of nicotine salts to supplement the alkalinity of the tap water, which in most instances is insuffiicent for freeing the nicotine from combining acids. The use of free nicotine, of course, obviates the

need of such addition but this form of nicotine in the concentrate is much more dangerous to handle and is subject to greater losses in evaporation.

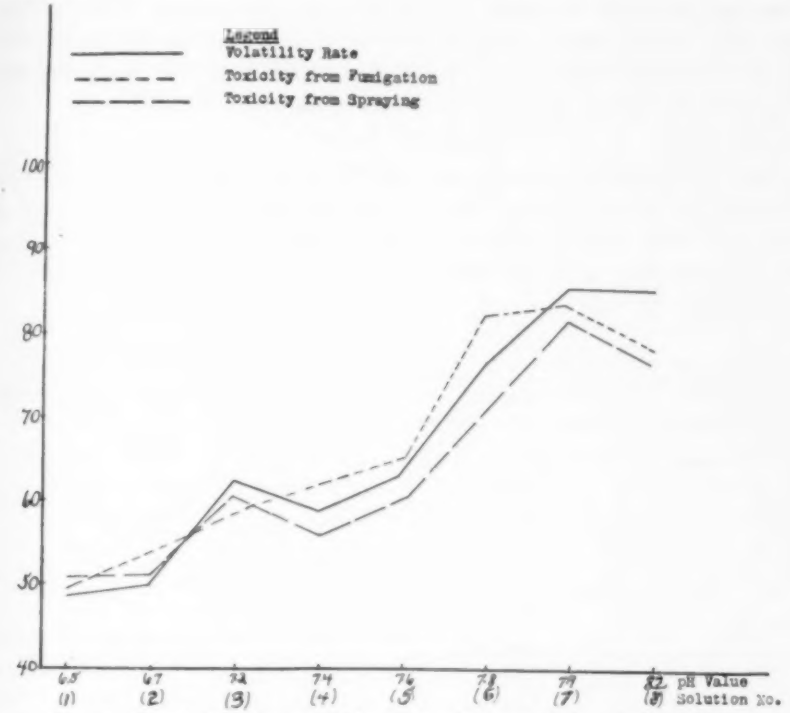

Fig. 5—Graph showing volatility rate and comparative toxicity from fumigation and spraying.

PRACTICAL APPLICATIONS. To obtain the maximum efficiency of nicotine sulfate solutions, a slight excess of alkali should be added over the amount needed to combine with the sulfuric acid present. To one pound of nicotine sulfate add three ounces of hydrated lime or freshly slaked burned lime. Then for a two-hundred gallon tank of 1–800 solution of nicotine sulfate, 6¾ ounces of lime would be required, supposing the nicotine solution had a specific gravity of 1.2. If soap is used as the spreader, then add three ounces of sodium hydroxide (commercial lye may be substituted) or four ounces of sodium carbonate. One of the most convenient forms for the latter is commercial soda ash.

Waters that are very alkaline might, with the addition of soap or calcium caseinate, neutralize the combining acid present. However, such waters are not common and, in most instances, the total alkali

present is insufficient to free the alkaloid. Since we have no method of determining easily when the alkaloid is completely freed, the safest plan is to add a slight excess of alkali. If calcium caseinate is used as a spreader, it might be possible to reduce the amount of alkali added, but since many waters contain considerable quantities of carbonates or other lime-precipitating chemicals too much dependence should not be placed on the excess alkali in casein spreaders.

Nicotine Dusts

The use of dust carriers for nicotine instead of water, as developed by Professor R. E. Smith, has been a great advantage in certain types of work but with it have come some complicated problems. This is due to three reasons: first, the dilutant is at present sold with the nicotine

Table III. Volatility of Nicotine in Various Dust Carriers.[3]

No.	Form of Nicotine	Carrier		Time of Exposure	Pct. of Nicotine Recovered
		Substance	Proportion		
			per cent	Hours	
1	Free nicotine	Hydrated lime Sulfur	74.7 24.2	18	22.3
2	Free nicotine	Hydrated lime Sulfur	49.5 49.5	18	25.3
3	Free nicotine	Hydrated lime Sulfur	87.8 11.2	18	32.1
4	Free nicotine	Hydrated lime Sulfur	11.2 87.8	18	trace
5	Free nicotine	Sulfur	99.0	18	none
6	Free nicotine	Hydrated lime	99.0	18	45.7
7	Free nicotine	Sodium carbonate	99.0	18	none
8	Free nicotine	Kaolin	99.0	18	96.3
9	Free nicotine	Hydrated lime Water	94.95 4.05	18	54.6
10	Nicotine sulfate	Kaolin	97.5	18	100.0
11	Nicotine sulfate	Hydrated lime	97.5	18	25.1
12	Nicotine sulfate	Sodium carbonate	97.5	18	none
13	Nicotine sulfate	Ammonium carbonate	97.5	18	none
14	Nicotine sulfate	Hydrated lime Sodium carbonate	48.7 48.7	18	trace

[3]Temperature range 58° to 70° F.

and at a high price; second, the release of nicotine from dusts varies with the type used and to a certain extent with the amount of moisture present; third, the stability of the nicotine as found in nicotine sulfate solutions is lost when alkali is added to "activate" it. Free nicotine is so volatile and subject to chemical changes that it has thus far been impossible to store it for any length of time without loss. This emphasizes the value of the "self-mixing" duster which gives immediate use of the nicotine when first freed. Since volatility and toxicity are so closely related, it is apparent that a dust which releases nicotine very quickly is desired for high concentrations of volatile nicotine over short periods of time rather than a slow release over an extended period. To quote Professor Smith, "The greatest possibility of reducing the amount of nicotine used lies along the line of making it as quickly volatile as possible."

The data given in Table III show that the hydroxide compound releases the nicotine more slowly than the carbonates. Hydrated lime ($Ca(OH)_2$) gave a slower release of nicotine both in free and sulfate forms than did calcium or sodium carbonate (Na_2Co_3). This agrees with the analyses given by Thatcher and Streeter (N. Y. Exp. Sta. Bul. 501). Professor Smith states in California Experiment Station Bulletin 336, that "Lime carbonate makes a very satisfactory filler but has no effect upon nicotine sulfate . . . . . Hydrated lime reacts with nicotine sulfate, forming free nicotine." The carbonate of lime which Smith was using was principally waste forms of lime which may account for the difference in results. Limited spraying tests with these two bases confirm the chemical analysis, i. e., the carbonate carrier is superior to the hydrate.

A comparison of free nicotine and nicotine sulfate is also given and so far as the tests are completed, do not indicate a material difference between these two forms of nicotine. It will be noted that free nicotine is less volatile with hydrated lime as a carrier than is nicotine sulfate from carbonate carriers. It is doubtful whether the added danger to the operator and the possibility of loss by volatilization would warrant the substitution of free nicotine for the acid compounds in the making of dusts, at least in the present stage of experimentation.

Chairman R. E. CAMPBELL: The next paper on spraying equipment for citrus trees will be presented by Mr. Herbert.

SPRAYING EQUIPMENT FOR CITRUS TREES IN CALIFORNIA

By FRANK B. HERBERT, *Assistant Entomologist, Balfour Guthrie & Co.*

ABSTRACT

There are two citrus districts in California,—Tulare County with medium sized open trees, where good results can be obtained with usual four horsepower spray machine,—and Southern California, with larger, denser trees, where the largest orchard sprayers (10 horsepower), are required. These machines have a capacity of 15 to 20 gallons per minute and carry 350 and more pounds pressure. Spray guns are used almost exclusively, with disc apertures ranging from $\frac{7}{64}$ to $\frac{9}{64}$ inches.

In Tulare County the average tree requires 8 to 10 gallons of solution, making a cost of 4 to 15 cents per tree for the application, and in Southern California, requiring 12 to 15 gallons, making the cost of applying run from 6 to 19 cents per tree.

From time to time growers and county officers have requested data on spraying equipment for citrus trees, with special reference to the pressure desirable, size of gun discs, number of gallons required per tree, cost of application, etc. Therefore the writer has endeavored to record some of the requirements in this paper, the data being taken from the records of sprayers and from general experience, and not from any special experiments performed.

CITRUS DISTRICTS

There are two distinct citrus districts in California. Southern California, where spraying on a large scale for any pests except red spiders, is quite new, and Tulare County, where spraying has been the principal means of pest control for a number of years. Full grown citrus trees in the former district become very large and require special equipment in order to properly cover them, while those in Tulare County average much smaller and can be more easily covered with the ordinary sized spray machine.

TYPE OF MACHINE

A great deal of the spraying in Tulare County is done by the individual grower who owns his own spray rig and does his work when he pleases. Most of these machines are of the larger sizes having single cylinder engines throwing from 8 to 12 gallons per minute. The "Bean" has been the favorite in this territory until now the "Friend" is coming to the front. As most of the trees are not over 15 feet high and are fairly open, the grower has been able to get by very well with this sized outfit. In quite a few cases the grower uses only one gun with this machine.

South of the Tehachapi, the commercial sprayer has been doing the bulk of the spraying, partly because it is a new business and partly because the trees have been so large that they required a large machine which the ordinary grower has not felt he could afford. Some of the smaller machines, which were used for spider spraying, are still in use,

but all the larger growers and commercial sprayers are demanding the largest orchard sprayers on the market, such as the Friend AXA, the Bean Super-Giant, and the Hardie Mogul. The Friend is the favorite here, having the largest capacity, besides being able to carry a pressure of 350 pounds or more with a minimum amount of upkeep. Each of these machines has a capacity of 15 to 20 gallons per minute and throws ample material to take care of two or more guns.

The sprayer when purchasing a new spraying outfit should not consider the initial cost alone, for with the cost of upkeep, the cheapest outfit is liable to more than balance the cost of the highest priced rig, without considering the aggravation and time lost from a poor machine. This applies particularly to the commercial sprayer, who must make every hour and dollar count for his season is short enough at best. The writer knows personally of a number of outfits requiring over $300.00 for upkeep per year, while more durable machines required only $10.00 to $35.00 for the same period.

Pressure

No one should attempt to operate a machine which will not carry at least 300 pounds pressure. This amount will suffice on small to medium sized open trees, but the best results on large trees have been obtained from machines carrying 350 to 400 pounds. A 130 acre grove of large trees in the Redlands section was classed as a 99.6 percent kill on Citricola scale last season. This had been sprayed with two medium sized rigs, but these results were obtained only by the most diligent work under and outside the tree, the sprayers even using ladders to reach the tops. The same results could have been obtained much more easily by using a rig with high capacity and pressure. Moreover this is the only grove of large trees where the writer knows of any such kill with a small rig. There have been a great many kills of better than 99 percent obtained much more easily where large outfits were used.

Spray Guns

The old time rod and nozzles have been replaced practically entirely by spray guns. If there is any occasion where the gun is more efficient than the rod, it is in spraying citrus trees. With the proper amount of pressure, the gun will break the material up and carry it to the tops of the tallest treess, and still do it more economically than any rod and nozzle. One hears occasionally from an "old timer" that he could do the same work and use less material with a rod. True, it could be done well with a rod, but only with the expenditure of a greater amount of energy and fully as much material. The only reason the rod might use

less material would be because the ordinary man hasn't the patience to stay at a large tree long enough with it to properly wet all the foliage. The gun will give a better washing and drenching effect on the tree than the rod.

The Friend and Hardie guns have proved to be the most popular makes. The Boyce double gun has been tried out to some extent, but has not proven to be any great success, except for medium sized open trees or for outside work, such as spraying for thrips. In inside work, which is essential in spraying for scale on citrus trees, the double gun gets caught to some extent on the foliage, and is tiresome to hold due to its heavy head. This same fault is found with the rod.

On the large machines the size of the aperature in the gun discs should be from $\frac{7}{64}$ to $\frac{9}{64}$ inches. If the machine is able to hold up its pressure with the larger discs, the more satisfactory will be the application for the greater the volume being forced through the gun, the farther the material can be thrown and this is essential on large trees. If at any time the material is being thrown too far, a simple turn of the handle widens the spray and shortens the distance it is thrown. With the smaller machines one should use one gun with a large disc or two with smaller discs, ranging from $\frac{4}{64}$ to $\frac{7}{64}$ inches. No gun should be used at less than 300 pounds pressure.

Hose

Some trouble has been experienced in getting hose to stand up under the high pressure used in Southern California. We find it must be at least seven ply and sometimes even this will give trouble in some brands. Half inch hose is used mostly, although a few of the large machines are equipped with $\frac{5}{8}$ inch material. The latter throws a nicer stream due to less friction, although it is considerably heavier to drag around. Two fifty-foot lengths are the usual equipment on each outfit.

Gallonage per Tree

In Tulare County the average amount of material required per tree is from 8 to 10 gallons. In some groves, 16 or 18 gallons are required to thoroughly drench the trees. In Southern California the trees average much larger, requiring 12 to 15 gallons, while some groves require as high as 25 gallons per tree. Individual trees have been seen that have had as high as 42 gallons applied before they were properly covered.

With small trees, two year olds require about one gallon each, 4 year olds, 2 gallons, 6 year olds, 4 to 5 gallons, with some of the thriftier taking as high as 10 gallons.

Cost of Application

Figuring in everything, it costs the grower who runs his own machine from ½ to $\frac{7}{10}$ cents per gallon to apply the spray, while the commercial sprayer charges from 1 to 1¼ cents per gallon, most of them charging the latter.

Thus the cost of application on the average tree in Tulare county is 4 to 7 cents where the grower owns his own rig, or 8 to 15 cents when hired done by a commercial sprayer. In Southern California the average cost runs from 6 to 10 cents for the grower, and from 12 to 19 cents for the sprayer.

This was followed by a paper by Mr. R. E. Campbell.

NOTES ON NICOTINE DUST PROGRESS

By Roy E. Campbell, *U. S. Bureau of Entomology*

Abstract

This general historical account of the use of nicotine in dusts, is given with special reference to recent developments, the properties of carriers, the utilization of finely ground tobacco dust, the comparative merits of free nicotine and nicotine sulphate, the advisability of a certain amount of moisture, the mechanical devices for the application of dusts, data on self-mixing dusters and the possibilities of local mixing. An extended bibliography is given.

When ground tobacco dust, because of variation and slow release of its nicotine content, failed to satisfactorily control the walnut aphis, Professor Ralph E. Smith began the use of a dust containing a definite amount of standardized nicotine sulphate solution added to a dry carrier. Following that work, the use of nicotine dust was taken up by the Federal Bureau of Entomology, and soon afterward investigations were also started in California, New York, New Jersey, Virginia, Connecticut, Ohio, Missouri, Maryland, Wisconsin, and other States. It is doubtful if in recent years any insecticide has aroused so much interest on the part of the economic workers as nicotine dust.

Kaolin was first used as a carrier because of its availability, ease of grinding, and inertness. It was found, however, because of its compound nature, to adsorb and "tie up" too much of the nicotine, and lime, being less subject to this objection, was substituted. Refuse sugar-beet lime and hydrated lime, together with finely-ground sulphur, also have been used most extensively. More recently the carbonates of lime and magnesia have proved to have certain advantages, particularly in giving off the nicotine very readily. A combination of these occurs naturally in dolomite, which is coming into favor as a carrier.

It soon became evident, after conducting many experiments and ob-

serving the results of others, that the entomologist had gone about as far as possible with the problem of carriers for nicotine dust. It was necessary for the chemist to investigate the nature of the reactions between the nicotine solutions and the different carriers. Experimental evidence indicated that nicotine dust was more effective when made up with certain carriers than with others, but the exact reasons were not well understood. As a result of the excellent work recently done by the economic workers of New York and New Jersey, we now know which carriers are active; i. e. (1) those which actually cause the nicotine to be released quickly; (2) those which are inactive and have no effect on the nicotine, except to expose it for evaporation, and (3) those which adsorb the nicotine and retard its release. It was also demonstrated that there is a difference in the reaction of nicotine sulphate and free nicotine to some of the carriers, and that the moisture content of the carriers affects dust made from the two types of nicotine differently. The entomologist can now proceed to find out whether a very quick release of the nicotine or a more gradual release gives the best killing, and whether free nicotine or nicotine sulphate makes the most effective dust. Probably these will differ in killing power when applied to different forms of insects under varying conditions.

The problem is further complicated from the manufacturer's viewpoint, who does not wish to make a dust which may lose its nicotine if held in storage for several months, nor a dust which retains the nicotine after the material has been applied. The ideal carrier would be one which retains the nicotine indefinitely in storage, but releases it readily when the dust is applied to plants. Perhaps the chemist may find some material, or combinations of material, suitable for such a carrier.

Nicotine dust was first manufactured by a cooperative walnut growers' association in 1918 at Santa Barbara, Cal. It proves so successful that a subsidiary company of the California Walnut Growers' Association was formed to make dust not only for its own growers, but for growers of fruit and vegetables as well. Since then the production has increased until there are at least five manufacturers of nicotine dust in the western, and six in the eastern United States. The total production of nicotine dust is shown as follows:

TABLE I. TOTAL PRODUCTION OF NICOTINE DUST IN THE UNITED STATES

Year	1919	1920	1921	1922	1923
Number of factories	1	2	3	8	11
Tons produced	400	225	425	970	1925*

*Production from one factory estimated for 1921, 1922 and 1923.

An interesting fact has occurred as a result of the rapid increase of nicotine dusting. It might be supposed, because of the large amount of nicotine used in the dust form, that liquid spraying with this material had decreased. On the contrary, the use of nicotine in dust form seems actually to have stimulated its use as a liquid spray, for more is being sold for this purpose than ever before.

Another development is a stimulation of the use of ground tobacco dust. Some manufacturers have advertised this material, but because of the variable amount of nicotine in ground tobacco and also because it does not volatilize so readily, its use has not been entirely successful. Recent experiments performed in New York with a finely-ground tobacco indicate that while on the basis of its nicotine content, ground tobacco is more expensive and slightly less active than nicotine dust, yet it gives sufficiently satisfactory results to be worthy of further investigation.

For several years the source of nicotine for all dusts was a solution of nicotine sulphate containing 40 per cent of nicotine. With this it was customary to use some hydrated lime, or other "active" material, which caused a reaction and liberated the nicotine. Recently some manufacturers are utilizing a solution of free nicotine which eliminates the need of using an "activator." There is a tendency also toward the use of a solution containing a higher percentage of nicotine. Some manufacturers claim better results with the free nicotine than with the sulphate, while others who continue the use of the sulphate, maintain that it is the most satisfactory. The free nicotine solution is a little more expensive, and the increase in the concentration of nicotine also increases its cost per unit. Recent experiments in New Jersey have demonstrated that a dust made of dolomite and free nicotine gave a better killing than one composed of hydrated lime and nicotine sulphate. The superiority of the free nicotine dust was due to a greater evolution of gas in a given period of time. It has also been demonstrated that nicotine sulphate in a dolomite carrier releases its nicotine more rapidly than in hydrated lime, so that the comparison of the two types of nicotine in two different carriers is not conclusive.

A certain amount of moisture is desirable in nicotine dust when compounded with nicotine sulphate, as the reaction is thereby hastened, but too much moisture is disadvantageous, because some of the nicotine may be dissolved. It is difficult also to thoroughly incorporate such a quantity of liquid into the carrier, without resulting in a dust which is too moist for satisfactory application. The presence of moisture is

especially undesirable in dust made with free nicotine, as the moisture has a tendency to absorb the nicotine. An excess of moisture may be partially overcome, in some cases, by the use of a drier, such as quicklime or plaster of Paris, but here complications may arise because of the action of these driers on the nicotine. The use of a solution containing a higher concentration of nicotine would, of course, remove both of the above objections in making high-strength dusts, but it in turn is objectionable because of the higher cost of the nicotine.

When the practice of applying nicotine dust as an insecticide was first begun, the only machines available were those which had been developed for dusting with arsenate of lead and sulphur. These machines were utilized for nicotine dusting, and were gradually improved to give a better feed of dust and a larger volume of air, since usually it was desirable to apply a greater amount of nicotine dust than of materials previously used, and in most cases to run the dust through the fan itself, thus breaking up any lumps which might have remained in the mixture. In addition, booms were perfected to apply the dust to rows or field crops as the machine was driven over them.

In order to hold the dust as long as possible around low-growing plants and at the same time to overcome the effects of wind blowing away the dust or fumes, several devices were made. One was a box-like enclosure, entirely surrounding the machine, into which the dust was discharged through individual pipes leading to the rows. Another device consisted in merely attaching a piece of canvas, a little wider than the strip of rows to be covered, to the back of the duster, and allow the canvas to trail behind. The canvas not only holds down the dust about the plants, but in dragging it over them, it knocks off many insects such as aphids. The increased activity of the aphids, in crawling about on the ground or the plants, renders them more susceptible to the action of nicotine. Some have used trailers 15 to 20 feet long, but the writer has obtained best results on peas infested by the pea aphis with one 40 feet long. The only limit to the length of the canvas trailer is the ease of handling it in turning at the ends of the rows. The canvas must not be long enough or heavy enough to injure the plants. It has been found advisable also to hang a weighted piece of canvas just ahead of the nozzles. This reaches below the tops of the plants and prevents the dust from escaping in front.

Other devices have been used, such as U-shaped inverted troughs, 4 feet long, attached to the rear of the dusting machine. A trough covers each row to be treated, and the dust is discharged into it. As

the machine proceeds down the rows, the troughs prevent the escape of most of the dust. These troughs are especially useful in windy weather.

Early in his work with nicotine dust, Professor Smith conceived the idea of a self-mixing duster, in which the nicotine solution and carrier could be mixed at the time of application. During the 1922 season such a machine was developed, being an adaptation of one of the regular dusters on the market. Early in 1923 two different firms began the manufacture of self-mixing dusters. Both of these have been tested, and while subject to some mechanical imperfections, as might be expected in new machines, the success of self-mixing dusters was demonstrated. The advantages of self-mixed dust are as follows: (1) The dust is much cheaper, being limited to the cost of raw products only; (2) it is perfectly fresh; (3) it is hot from the mixing and chemical reactions, and therefore more active; (4) there is no loss of nicotine from storage, and (5) it is possible to make quickly any strength desired. Of course, there still will be a large demand for the ready-made dusts, for use in the machines not suited for self-mixing, and in hand dusters. Many growers do not care to take the time and trouble of mixing their own materials, while others feel that with the type of labor available in some localities, the possibility of using the wrong dosage and improper mixing will be too great. The self-mixing dusters can be used for applying ready-made dusts, arsenate of lead, sulphur, or other necessary material.

Considerable emphasis has been placed on the thoroughness of mixing nicotine dust, and many have doubted if the self-mixing machines would do this satisfactorily. Professor Smith recently tested this by placing 40 pounds of hydrated lime and 2 pounds of 40 per cent nicotine sulphate solution in the hopper and running the machine for two minutes. A sample was then taken from near the top and one from near the bottom of the hopper. The machine was then run 8 minutes and two more samples taken. These were analyzed by the California State Department of Agriculture and showed the following percentages of nicotine: 1.88, 1.89, 1.88 and 1.87, thus definitely proving the evenness and thoroughness of the self-mixing operation.[1]

A later analysis gave the following results:

[1]Data from personal correspondence.

TABLE II. ANALYSES OF NICOTINE DUST FROM SELF-MIXING DUSTER. DUST MADE WITH 2 POUNDS OF 40 PER CENT NICOTINE SULPHATE AND 50 POUNDS LIME

Sample	Time of mixing	Remarks	Sample taken from	Nicotine content
1	1 minute	Lumps discarded		1.41 per ct.
A	2 minutes		Side	1.23 "
B	2 "		Center	1.49 "
C	2 "		Deep center	1.44 "
D	2 "		Side	1.38 "
E	2 "		Center	1.59 "
X	2 "	Ran 1 min. lumpy Then ran 2 mins.		1.59 "
B3	3 "			1.56 "
B31	3 "			1.56 "
B3c	3 "		Deep center	1.43 "
B3s	3 "		Side	1.41 "
B3T	3 "		Top	1.54 "

A recent development in the distribution of this compound has been local manufacture of nicotine dust. This involves both mixing and distribution by local dealers or growers and makes available high grade dust in small quantities.

Nicotine dust prepared by a large manufacturer and shipped long distances is necessarily somewhat high-priced. To the cost of making and the manufacturer's profit, must be added necessary profits for the distributor and retailer, which, with rather high freight rates, may make the price per pound almost double the actual cost of the raw materials.

Mixing machinery is neither very expensive nor complicated. As a consequence, local dealers in communities where there is considerable demand for nicotine dust, especially where they are located at some distance from a manufacturer, are installing their own machinery, and buying the raw products, mixing and selling the dust directly to the growers. When this is done the distributor's profit, and often the retailer's profit can be deducted, as well as the freight charges, which permits the sale of the dust at a very low rate.

The large manufacturer can, of course, compete with such local manufacturers by installing mixing machinery at his branch houses, and by dealing directly with retailers or growers, thus eliminating freight rates for long hauls on the manufactured dust, and also the distributor's or jobber's profit. It is probable that ultimately most of the nicotine dust will be made either in the self-mixing machines, or by a number of comparatively small local manufacturers, distributed over

the country, and that such manufactured dust will be used within a territory a few hundred miles from the factory.

Such manufacturers will have the advantage of being able to sell cheaply to local trade and to make up an order and quickly send out freshly-made dust, thus largely eliminating the possible deterioration while in storage, and furthermore will be able to specialize on the type of dust best suited to their particular localities.

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A discussion on dusts was led by Mr. Campbell. Among other things there arose the question as to when an entomologist should recommend control measures. Some differences of opinion developed, but it was generally felt that insects with only one or possibly two generations a year must be considered differently than those with many generations and which develop serious infestations in a few weeks. It was finally agreed that the best rule to follow was to consider the infested crop or orchard as if owned by the entomologist and make control recommendations accordingly.

Meeting adjourned.

Afternoon Session, September 18, 1923

The excursion, previously announced, was attended by 30 members and visitors, who were shown the process of manufacturing nicodust and dusting machines, liquid hydrocyanic acid gas and calcium cyanide, and the methods of propagating and rearing parasites and predaceous insects for biological control.

Morning Session, September 19, 1923

The meeting was called to order by chairman R. E. Campbell who announced the order of business as a symposium on biological control under the leadership of H. S. Smith, in charge of Beneficial Insect Investigations, Univ. of Calif.

The following papers were presented:

WHAT MAY WE EXPECT FROM BIOLOGICAL CONTROL?

By HARRY S. SMITH, *University of California, Citrus Experiment Station*

ABSTRACT

Biological control work has been subject to extremes of popular approval and disapproval. This is due to a lack of understanding, on the part of the general public, of just what results may reasonably be expected from this method. Success is dependent upon biological principles with which the grower is not always familiar. Some insect pests are favorable subjects for attack by this method and others are not. It is pointed out that the proper co-relation between host and parasite and freedom from secondary parasites, are important factors in this type of control. The future is bright for this branch of economic entomology.

The control of citrus pests by the use of their natural enemies is a phase of scientific agriculture which has appealed to California growers for many years. At no time since the introduction of the Australian ladybird, Vedalia, in the early 80's, which resulted in the saving of the citrus industry from the ravages of the cottony cushion scale, has the California fruit grower lost interest in this method of pest control. His interest in the subject has not, however, been at a uniformly high pitch during this entire period. The introduction of Vedalia was naturally followed by a wave of enthusiasm for the introduction of parasites, not alone among growers but among some entomologists as well, which, as we have since learned, was hardly justified but which is easily understood in view of the striking results of this introduction. During this period the feeling was quite general in California that any pest could be controlled simply by the introduction of *its parasite*.

For several years after the introduction of Vedalia enthusiasm was high; but failure to secure similar results with other insect pests had its effect and interest began to slacken somewhat. Then Scutellista, a parasite of the black scale, was introduced from South Africa in 1902.

This parasite thrived wonderfully under California conditions and gave promise for a time of doing to the black scale what the Vedalia did to the cottony cushion scale. As time passed, however, and the black scale failed to disappear from the orchards in spite of comparatively heavy parasitism, this second wave of enthusiasm for the biological method of pest control began to lose its force. From then until 1918 was a period during which there was no more than a very general interest in this method. In 1918 the work of the California State Department of Agriculture on the biological control of the citrus mealybug began to make itself felt and interest in this subject began to reawaken. It was not, however, until the successful introduction and establishment by the Department of *Aphycus lounsburyi* Howard as an aid in the control of black scale, that interest in biological control again reached its height. History repeated itself, and there was a tendency again to expect greater results than the facts in the case warranted. However, this wave of what might be termed "over-enthusiasm" has receded, and there is now, I believe, a pretty general understanding on the part of the growers of just what may reasonably be expected in the way of control of the black scale by Aphycus.

My purpose in calling attention to the effect on the interest of the fruit grower of these various efforts to control pests by the biological method is to bring about a better understanding as to just what part natural enemies should play in our general scheme of pest control. Over-enthusiasm generally has a reaction which is not beneficial. The greatest good will come from biological control only when the majority of our agriculturists have a better understanding of the principles involved and the limitations to which the work is subject.

In appraising the possible value of the biological method as a pest control measure, there are certain more or less fundamental biological principles which must be taken into consideration.

In the first place, just what is meant by "biological control?" It means the suppression of insect pests by the use or encouragement of those organisms which in nature tend to reduce their numbers. All forms of life are subject to the action of factors which limit their increase. The most important of these are meteorological conditions, which include heat, rain, cold and drought; limited food supply; fungous and bacterial diseases, which destroy numbers of insects, especially in the more humid climates; and predatory and parasitic enemies. These various limiting factors taken together form what is known as "natural control."

On account of the fact that in California fungous and bacterial diseases of insects do not generally thrive, biological control in this state resolves itself into a matter of making use of beneficial insects alone.

While all insects have natural control factors working against them, they do not all have natural enemies among the parasitic and predatory insects, at least not effective ones.

Some insects are serious pests not because they have been introduced from a foreign country without their natural enemies, but because man has altered their environment in such a way as to provide a more satisfactory habitat and food. The Colorado potato beetle is a good example of this type. It is a native of the plains region at the base of the Rocky Mountains and its native food plant is the sand-bur, *Solanum rostratum*, a plant related to the potato. Upon the introduction of the potato, this beetle transferred its attention to that plant, and finding it much more to its liking, was able to multiply more rapidly and thus developed into a serious pest. A somewhat similar case is that of the grape Phylloxera, which is also a native insect and which became an important pest because of the introduction into the United States of the *vinifera* varieties of grapes from Europe, a type of grape which was a more favorable food plant than the native American grapes and which had developed no immunity to the pest.

Neither of these insects has natural enemies of importance and therefore the biological method is not applicable so far as at present understood. I cite these two cases merely to emphasize the fact that there are certain pests against which there is apparently no possibility of using this method in a practical way.

A general study of the problem indicates that the relative importance of insect enemies in the natural control of pests varies all the way from practically nothing, as in the cases above cited, to the most important of all factors making up natural control, as exemplified in the case of the Vedalia and the cottony cushion or fluted scale. Since, in California at least, the application of the biological method is practically confined to the use of insect enemies, the applicability of this method to the control of pests is dependent upon the availability of effective parasitic and predacious insects. It should be plain therefore that the degree of control which may be effected, may vary all the way from nothing to practically complete control, depending upon (1) whether or not effective natural enemies exist, and (2) whether introduced natural enemies find climatic and other environmental conditions satisfactory for their multiplication in their new habitat. This is, of course, a

statement of perfectly obvious facts, but there are many complications which enter into the situation and determine the *degree* of control which may be brought about.

Assuming that natural enemies of apparent value are located and successfully shipped to destination, that their life-history and habits are definitely determined and that a sufficient breeding stock is on hand, upon what conditions does practical success depend? Among known factors which bear on this question the following are important:

There must be the proper co-relation between the life-history of the parasite and that of the pest. No better demonstration of this principle could be asked than that exhibited by the black scale and the Aphycus. Aphycus thrives in the coastal areas of the state, where the life-history of the black scale is such that the stages of development upon which Aphycus is able to breed exist at all times of the year. On the other hand, it does not thrive in the interior, where for several months at a time these stages are not present and the parasite is therefore unable to maintain itself in abundance for lack of the proper hosts. This principle is fundamental. It is conceivable however that we may find parasites whose life-histories more nearly correspond to that of the black scale under interior conditions. The same is probably true of the citricola scale, which has only one generation a year. On the other hand the red and purple scales have several generations per year and from this standpoint are more favorable subjects for biological control. Because most scale parasites are short-lived and must pass through several generations a year to maintain themselves in abundance, it follows that scale insects such as the red and purple scales, the black scale under coastal conditions and the mealybugs are more favorable subjects for biological control than are such pests as the citricola scale or the black scale under interior conditions. There are however two possibilities by which these latter pests might be brought under control by the biological method. We may succeed in finding parasites which have life-histories corresponding to that of these scales or predators which feed on all stages, or we may develop methods of propagation of the natural enemies in such a way that we can afford to stock the orchards artificially every year with the parasites. The latter procedure may seem far-fetched, but the possibilities of this kind have not been exhausted. The control of these pests costs the citrus growers as much as $50 per acre per year. A very considerable sum could be expended in the production of natural enemies for orchard use, and still leave a margin of profit over fumigation costs, provided, of course, it could be done with equal effectiveness.

The writer is quite free to admit this has not yet been demonstrated except in the case of the mealybug.

The beneficial species which are to be employed must be comparatively free from the retarding effects of secondary parasites existing in the local fauna, which sometimes strongly attack the primary parasites used. Undoubtedly in some cases this factor will be sufficient to render the work unsuccessful, because when by artificial manipulation a superabundance of natural enemies of the pest is created, we thereby form an environment which is favorable for the secondary parasites. In other cases this will merely serve to reduce the degree of control. In most instances it will be practically impossible to foretell just what would happen in this direction and a practical attempt must be made in order to ascertain just what part the secondary parasites would play, and also the primary parasites of predacious insects. Undoubtedly this factor will limit or entirely prevent the control of some of our insect pests by this method. The attack of secondaries which occurred in the local fauna before the introduction of *Aphycus lounsburyi* has already greatly reduced the effectiveness of that valuable parasite, and this was also true in the case of certain parasites introduced into New England by the United States Department of Agriculture for control of the Gipsy moth. We can and do by careful work exclude new secondaries, but there are native secondaries which frequently attack the newly introduced beneficial insects. This of course cannot be prevented.

It seems hardly necessary to state that these two principles, i. e., the adaptability of the beneficial insects to their hosts and their relation to secondary parasites, are the ones on which in a large measure success will depend, and the degree of success attained will vary in accordance with the fulfillment of these requirements. The important thing to be impressed upon the general public, and the thing which has not been generally understood in the past, is that so far as our present knowledge goes not all pests are susceptible to control by the biological method, but that *most of them can be influenced to some extent* by the use of natural enemies, the degree of control being dependent largely upon ecological factors. When this is thoroughly understood there will be less false hope aroused and fewer disappointments and, in the opinion of the writer, the work will be strengthened thereby.

In the actual work of locating new parasites in foreign countries and in collecting, shipping and rearing this foreign parasitic material, many very difficult problems are met. Transportation of material, especially when collected in such far-away places as India, China or South Africa,

is very troublesome even when cold storage is used, and in many instances it has been necessary to persist for several years before a successful shipment is made. The successful shipment of material to this country is only part of the battle. Careful life-history studies of the parasite must be made to determine beyond any doubt that it is a primary in its habits, that is, that it will not attack any of our beneficial species, as the Quaylea does the Aphycus at the present time. With only a very limited supply of breeding stock available and with a parasite of more or less unknown habits, this is difficult and frequently results in the loss of the colony. Often the two sexes do not appear at the same time, with the result that the shipment is finally lost through lack of fertilization of the eggs. Most of these difficulties can however be overcome by sustained effort and are not a permanent barrier to success.

The writer confessses to a feeling of optimism for the future of biological control work. The field has scarcely been scratched. There are thousands of species of beneficial insects throughout the world. There are great improvements to be made in the propagation and manipulation of species already available. The work has its limitations just as does the control of human disease by the use of serums, vaccines and antitoxins, but even partial success will return a large profit on the sum invested in such projects.

THE PRESENT STATUS OF *APHYCUS LOUNSBURYI* HOW. IN SOUTHERN CALIFORNIA

By H. M. ARMITAGE, *University of California, Citrus Experiment Station*

ABSTRACT

In the "uneven hatch" areas secondary parasitism has precluded *Aphycus lounsburyi* How. becoming, by itself, an adequate means of control of black scale, except, possibly, at irregular intervals. Eight hyperparasites are known to attack Aphycus and three others are under suspicion. It is, however, of much value in the uneven-hatch areas as an aid to fumigation by evening up the hatch.

In the interior or "even-hatch" areas, low temperatures which cause retarded development of Aphycus, particularly in the pupal stage, during the one short period when it might alone control the scale, prevents its doing so. Aphycus, with *Scutellista cyanea* and *Rhizobius ventralis*, completes a sequence of enemies attacking the black scale and this fact offers a possiblility of control.

The distribution of *Aphycus lounsburyi* has been so complete, both with and without human agency that it is safe to say there is hardly a citrus orchard, or for that matter a planting of ornamentals or growth of native shrubbery in Southern California, infested with black scale, in which it is not possible to find Aphycus or evidence of its work. In spite of the many factors operating to its disadvantage it is without question a most valuable addition to the parasite fauna of California.

Four years observation on the work of *Aphycus lounsburyi* How. as a parasite of the black scale, following its introduction and successful establishment in the citrus orchards of Southern California by the

State Department of Agriculture in the fall of 1919, have definitely established its limitations as a factor in the control of that pest. They have also corroborated, to a large extent, the results of the work carried on in the early experimental plots and have brought to light a factor, secondary parasitism, which it was hoped might be avoided.

As has been fully explained in the earlier reports of the introduction and establishment of this parasite, two distinct field conditions termed "uneven hatch" and "even hatch," required consideration in determining to just what extent it might become a factor of control. These two field conditions, the first of which embraces the coastal areas in which the scale has one or more overlapping generations, and the second, the interior areas with a single uniform generation must still be considered separately in recording the present status of this parasite.

Coastal or "Uneven-hatch" Conditions

At the time of its introduction it was obvious that the mild climate of the coastal areas together with the overlapping generations of the black scale, offered an ideal condition for the Aphycus to gain the ascendency through rapidly succeeding generations, if it was at all adapted to California's climatic conditions. Little surprise was occasioned, therefore, among those carrying on the work at the rapidity of its spread and the apparent thoroughness of its work in these areas when once established. Appreciating, however, from previous experience with such problems, that newly introduced insects often have an immediate "flare-up" which they are unable to maintain through succeeding seasons, every effort was made not to create any undue enthusiasm among the growers, and in fact this policy was so closely adhered to that it reacted to the extent of the growers taking matters into their own hands. The efficiency of the Aphycus was so obvious to them that they hailed it as a second Vedalia. Wide-spread distribution of field-collected parasites was made through their own organizations. Large tracts of orchard were allowed to go untreated otherwise, in many cases successfully the first two seasons; later, however, there was a heavy loss from the smutting of the fruit and foliage from a heavy infestation of scale; sale of fumigation tents was even considered but fortunately never carried out.

Burdened with an annual fumigation bill running well into seven figures, the growers are perhaps not to be blamed for grasping at such a promising "straw" in their efforts to reduce costs. It is with regret that I find it necessary to record that a factor, secondary parasitism, not entirely unexpected but one which it was hoped might be avoided, has entered into the question and has reduced the efficiency of the Aphycus

in the "uneven-hatch" areas to a point where it cannot alone control the black scale. It is, however, logical to assume that this secondary parasitism will result in the usual cycle, with recurring periods of efficiency on the part of the Aphycus followed by periods of ascendency on the part of the secondaries.

Up to the present time eleven hyperparasites have been taken associated with Aphycus. Eight of these have been demonstrated experimentally in the laboratory to attack the Aphycus, the other three being under suspicion. Those already demonstrated include in the order of their importance, *Quaylea whittieri* Gir.; a species of Eusemion, undescribed; *Tetrastichus blepyri* Ash.; three species of Cheiloneurus; *Eupelmus inyoensis* Ash., determined by Gahan; and *Thysanus niger* Ash. The three under suspicion include one Cheiloneurus, one Eupelmine and a Perissopterus determined by Gahan as *mexicanus* How.[1]

Quaylea whittieri Gir. is by far the most important hyperparasite attacking the Aphycus, in California outnumbering by far all of the others combined. Recovered rarely on *Scutellista* previous to the introduction of *Aphycus lounsburyi*, it sprang into prominence immediately the latter became abundant in the field. The Quaylea became so abundant in some districts that at certain seasons of the year they were noted swarming by the hundreds around the tops of the trees on the ends of the new growth. In one case, from fifty selected scale parasitized by Aphycus, two hundred and thirty-three specimens of Quaylea were dissected and only five Aphycus were found to have escaped attack. In innumerable instances the Quaylea demonstrated their ability to parasitize all of the Aphycus, from two to seventeen, within a single scale.

An undescribed species of Eusemion is second in importance as a parasite of the Aphycus. While occurring throughout Southern California to a greater or less degree it has been particularly abundant in Ventura and Los Angeles counties. *Tetrastichus blepyri* Ash. has also been rather abundant in the two counties mentioned. The other secondaries mentioned have been taken only in limited numbers.

It is worthy of note that the secondaries are most abundant in those areas in which the distribution of the Aphycus was most actively carried on, because of the rapidly increased amount of host material available for their attack. In those areas, this season has seen practically every acre treated mechanically by either fumigation or spraying. The Aphycus, however, has not died out in these districts; it is very much

[1]I am indebted to Mr. Harold Compere, Assistant Entomologist, Beneficial Insect Investigations, University of California, for the above determinations. Mr. Compere is preparing for publication a paper covering these hyperparasites in detail.

in evidence, but it has not been able to maintain itself in controlling numbers.

While conditions have made it practically impossible for the Aphycus alone to control the scale in the "uneven-hatch" areas it has been of unquestioned value as an aid to mechanical treatment. Due to the unevenness of the hatch of the scale, fumigation results are not always satisfactory. If the fumigator waits for the last egg to hatch, those scale which hatched out first often develop to a size immune to such treatment. Aphycus, attacking the adult scale during the period of oviposition, which averages approximately sixty days, has destroyed them before egg laying has been completed. This has a marked tendency to even up the hatch and at the same time advance the date of beginning fumigation operations, thus extending what is ordinarily an altogether too short fumigation period. Scale development is so rapid under coast conditions that many of the Aphycus which escape the fumigation in the pupal stage, are able to bridge the short gap as adults and parasitize those scale which owing to their size escaped the treatment.

Interior or "Even-hatch" Conditions

While the State Department of Agriculture was confining its liberations of the limited amount of Aphycus available for distribution to the coastal areas, the growers in those areas were passing on their enthusiasm to those of the "even-hatch" areas together with a large number of parasites. These were enthusiastically received in spite of the Department's warning of an entirely different field condition to be met and a certainty from the results of early experiments that very little should be expected of them. Evidence of the faith of some growers in the reports which filtered into the newspapers is found in the following short, concise letter received at the State Insectary at Whittier from a grower in one of the farthest inland citrus districts. The letter follows:

"Gentlemen:—

Please send me sufficient Aphycus for eight hundred acres and oblige,

Very truly yours,"

The "even-hatch" areas embrace the interior sections which have a much wider seasonal temperature range and much lower humidity than the coastal sections. By far the greater part of the citrus acreage in Southern California lies within these areas. It was early found that the single uniform generation of scale in these areas limited the period of attack by the Aphycus to approximately two and one-half months in the spring. It is necessary that control be obtained before oviposition by the scale, for the reason that if the scale were allowed to reproduce

itself it would not again be susceptible to attack that season, the Aphycus would largely die out and the new season would begin with as heavy an infestation as the previous one. Strictly speaking the Aphycus would not entirely die out each season, as it has been found that there is always more or less off-stage scale throughout the year on certain of its more succulent host plants, sufficient to carry over a small number of Aphycus from one season to the next.

It has been determined that February 15 is the earliest possible date at which scale of a size suitable to the attack of Aphycus could be found under these conditions. It was thought that if a sufficient number of Aphycus could be liberated at this early date, there would be sufficient time to secure control through the two or possibly three generations which laboratory experiments indicated were possible in the period before the beginning of egg laying by the scale. Field work however soon demonstrated that the prevailing temperatures at that season of the year so retarded the development of the Aphycus, particularly in the pupal stage, that it was practically inactive until after reproduction by the scale had started. One citrus association expended $50,000 this season in an effort to place a sufficient number of parasites in its orchards to offset the short period of effective attack. Though they were able to liberate between five and ten million Aphycus during the spring months, over their properties, they did not succeed in obtaining the desired results. Under these conditions it is obvious that in the "even-hatch" areas the Aphycus can never, by itself, control the black scale. But while this is true, the Aphycus offers other possibilities of value, as in the "uneven-hatch" areas. As a body parasite of the third or "rubber" stage and the ovipositing adult itself, the Aphycus assists in completing a sequence of enemies attacking the black scale, filling a gap between the ladybird, *Rhizobius ventralis*, and *Scutellista cyanea*. This sequence offers a possibility of control under proper handling.

One of the faults of Scutellista has been that almost always it has matured before oviposition by the scale has been completed, with the result that many eggs have escaped destruction and a heavy infestation of scale has followed in spite of an abundance of this parasite. The Aphycus materially increases the efficiency of the Scutellista by attacking the ovipositing adult scale and reducing the period of egg laying, thus making it possible for the Scutellista to consume all of the eggs deposited. That the Aphycus and Scutellista are socially inclined is shown by the frequent finding of both attacking one scale. In one

instance five Aphycus pupae were removed from the body of an adult black scale and three Scutellista pupae were taken from the egg cavity.

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THE SUCCESSFUL INTRODUCTION AND ESTABLISHMENT OF THE LADYBIRD, *SCYMNUS BINAEVATUS* MULSANT, IN CALIFORNIA

By HARRY S. SMITH, *University of California, Citrus Experiment Station*[1]

ABSTRACT

A South African ladybird, *Scymnus binaevatus*, after several unsuccessful attempts, has been colonized on several mealy bugs throughout California. There is a prospect of its becoming of considerable value as a check on these pests.

Mealybugs of several species are among the most important pests of horticulture in California, and up to the present time they have to a large extent proven resistant to all attempts at control by means of fumigation or spraying. This has made them particularly attractive subjects for control by the biological method; several valuable parasites and predators have been introduced into California for this purpose, and very satisfactory practical results have thus been secured.

Among recent introductions is that of the ladybird, *Scymnus binaevatus* Mulsant, from South Africa.

For several years the writer has been in correspondence with Mr. C. W. Mally, Entomologist for the Union of South Africa, at Capetown, with reference to a ladybird existing there, reported to be of importance as an enemy of mealybugs. When Mr. E. W. Rust, parasite collector for the State Department of Agriculture (now for the University of California) was sent to South Africa, he was asked to secure a colony of this ladybird for use in California. This he did and several shipments were made via Australia, but owing to the long journey none of them arrived in a living condition. When Mr. Rust began his return trip to this country in the fall of 1921 he brought a large colony with him

[1]The beneficial insect work was transferred from the California State Dept. of Agriculture to the University of California on July 1. The introduction described in this paper took place before that time.

as far as Sydney, Australia, where, owing to the necessity of making further investigations in that locality, he placed them aboard a steamer for San Francisco. This shipment like its precedessors was unsuccessful, and immediately upon its receipt Mr. Rust was advised of the situation by cable. He had very wisely left a stock in care of Mr. Mally at Capetown and at once cabled him to send another colony to him at Sydney. This was done and by stopping at Honolulu enroute for fresh food for the ladybirds Mr. Rust was able to reach California with 29 living specimens. These were rushed to the Whittier Laboratory where they were given an opportunity to propagate, which they did so effectively that within a year approximately 250,000 were colonized throughout the state.

Mr. Rust writes as follows with reference to this species:

"In South Africa it is quite commonly encountered and does much beneficial work against various mealybugs, but in its native home it is preyed upon by a parasite which often decimates it, and so keeps it from being as effective a check on its host as would otherwise be the case. This parasite (*Homalotylus africanus* Timb.) gave a great deal of trouble in the insectary at Capetown while material was being reared for shipment to California and it was only by exercising a good deal of patience that the parasite was finally eliminated and a good clean stock of ladybirds built up for shipment. However, this was finally accomplished and the coccinellids were brought to California without their parasite, so here they should increase very rapidly, being free of their hereditary foe."

Scymnus binaevatus is very distinct in appearance from any California species of the genus because of its greatly elongated body. It is blackish in color with a brown spot on each elytron. The larvae are very similar to those of other species of Scymnus, being covered with a white, waxen secretion. This ladybird has the habit of seeking crevices in bark and other hidden places for feeding, a habit which is of especial value in the case of certain mealybugs which would otherwise escape its attack.

This ladybird has been colonized throughout the state, on *Pseudococcus citri*, *P. gahani* and *P. maritimus*. Besides southern California colonies, it has been liberated in the counties of Tulare, Fresno, Kings, San Joaquin and Alameda in northern California. The first field liberation was made in March, 1922. It has since been recovered in the orchards in abundance at Santa Monica, Pasadena, Alhambra, Oxnard, Rivera and San Fernando. As many as 50 adults have been found in a single burlap band. Recoveries so far have been made only in orchards

infested with citrophilus mealybug, but insufficient search has been made in case of other infestations to justify any conclusion that it will not attack the other species. It is believed that this ladybird will become of considerable value in the control of the above mentioned species when it has had sufficient time to become thoroughly established.

Through the courtesy of Dr. L. O. Howard, specimens of this ladybird were studied by Mr. E. A. Schwarz of the National Museum, who reported as follows:

"The small Scymus from South Africa is most probably identical with *Scymnus binaevatus* Mulsant (1850), described (apparently from a single specimen) from "la Cafrerie." The type is now in the Stockholm Museum. Mulsant's description agrees very well with Mr. Smith's specimens but it is not known to me at present whether or not other African species of Scymnus allied to *S. binaevatus* have been described by recent authors. It would be safe, therefore, to refer to the species as "*Scymnus (Sidis) binaevatus Muls.?*".

THE HISTORY OF HYDROCYANIC ACID GAS FUMIGATION AS AN INDEX TO PROGRESS IN ECONOMIC ENTOMOLOGY

By R. S. Woglum, *Entomologist, California Fruit Growers Exchange, Los Angeles, California*

Abstract

Hydrocyanic acid gas fumigation was discovered in 1886. From 1886–1893 it underwent decided improvement as a fumigant for citrus trees; 1893–1900, greenhouse, nursery stock, stored products and mill fumigation were introduced; 1907–08, orchard fumigation was standardized; 1910–13, sodium cyanide displaced potassium cyanide; 1912, portable machine generator invented; 1913–14, vacuum fumigation developed; 1916, liquid hydrocyanic acid first used for fumigating; 1923, calcium cyanide dust experimented with as fumigant.

The ascendency of American economic entomology during the last half of the 19th century appears attributable primarily to the development of methods which offered noteworthy relief to agriculturists suffering from insect depredations. The maintenance of this supremacy in pest control has rested largely on the discovery of new or the improvement of old methods or practices. The history of hydrocyanic acid gas fumigation during its thirty-seven years of use is peculiarly illustrative of entomological progress. It appears a fitting topic at this meeting as its discovery in 1886 by Coquillett was made in Los Angeles, the first experiments being conducted in the famous Wolfskill Orchard, now displaced by the Southern Pacific Station. Much of the later progress in fumigation has also been made in Southern California.

Coquillett's discovery was the outgrowth of unsuccessful efforts to

control the cottony cushion scale with sprays. In its earliest stages, the gas process was interesting rather than fully practical. The tents were bell-shaped, very heavy, sometimes oiled, and almost gas tight. Very cumbersome equipment was used to move these tents over trees. The process was slow and necessarily expensive. The generation process of concentrated acid slowly dropping onto dry cyanid, or into a cyanide solution was prolonged and somewhat uncertain of uniformity.

By the early nineties, fumigation had undergone vast improvement. The heavy bell-shaped tents had given way to flat octagonal sheets of untreated tightly woven canvas. The advent of flat sheets which could be moved by two poles greatly simplified the covering and reduced the cost of the operation. The simple pot method of generation, which consisted of dropping solid cyanide into a dilute acid had come into use. Day fumigation had given way to night fumigation, which meant less plant injury. The greatest weakness of the system at that time was the lack of an accurate and practicable method of estimating the dosage, and this condition was reflected in one way or another throughout the first 20 years of orchard fumigation, at times receiving no small amount of attention from California investigators, particularly Woodworth. Nevertheless, the system as a whole proved sufficiently satisfactory that it rapidly became the standard of scale-insect control in California, a position maintained up to the present time. From 1893 to 1907, there was no outstanding development in orchard fumigation other than in increased volume of work done. Conflicting ideas between fumigators on dosage, exposure, proportion of chemicals and general procedure, however, became numerous.

The last fifteen years have seen the greatest progress made and the most rapid changes in fumigation since its earliest days. The development by Morrill in 1907 of a practical method of marking tents for the calculation of dosage was the most important step toward accurate orchard fumigation. The writer introduced this marked tent method of fumigation into California in 1908, strengthening it by a dosage schedule adapted to the fumigation of any citrus tree pest against which fumigation is practiced. The superiority of the marked tent system with its sliding scale of dosages rapidly became apparent to growers and fumigators alike and for the last decade has completely supplanted all other methods wherever orchard fumigation is practiced.

Potassium cyanide exclusively was used in fumigating up to 1909. The work in 1908–09 of Woglum and McDonnell showing the availability of high grade sodium cyanide for fumigation formed the basis of con-

version from a potassium to a sodium basis in 1910–1913 when the price of potash products increased. Since 1914, sodium cyanide has dominated the field in all lines of fumigation.

In 1912, William Dingle, a practical fumigator, invented a portable machine for generating gas outside the tent from cyanide in solution. Subsequently a modified type of generating machine known as the cyanofumer was developed in Los Angeles and displaced the pot system very largely in California in 1915–17. Although this new method did not appear superior to the pot method in scale control, it was an improvement in several ways over the more cumbersome pot method from the standpoint of the fumigation manager.

One of the greatest forward steps in fumigation was the development of liquid hydrocyanic acid by William Dingle in 1916. Mally, in South Africa was experimenting in a small way with the same chemical almost simultaneously but entirely independently. The simplicity of the "liquid gas" method, as commonly termed, led to its immediate adoption in California. A combined attack on the problem by entomologists, chemists, manufacturers and fumigators quickly led to the development of a standardized system of liquid gas fumigation with a uniformly high grade product. Today fully 90 per cent of the 2½ million dollar annual fumigation campaign in California comes under the liquid system, the remaining 10 per cent being divided between cyanofumer and pots. Three large manufacturing concerns are now in the field, one making the liquefied product from sodium cyanide, one from calcium cyanide and the other synthetically.

Methods of application have undergone repeated changes and no less than 12 different types of generating machines have been developed and used since the method originated. Some of these machines have been adapted for atomization of the liquid through a mist nozzle while others convert the liquid to gas by heat. A very large amount of valuable data bearing on the limitations of liquid hydrocyanic acid for orchard fumigations has been accumulated. One reflection of this information is the greatly increased practice of daylight fumigation, a decidedly hazardous operation in former days with pot or cyanofumer.

The most recent development in fumigation has been the use of calcium cyanide as a dust. Quayle was the first to use this material for fumigating beneath a tent. At the present time calcium cyanide dust as an orchard fumigant is merely in the experimental stage. Preliminary work appears to have shown it very effective against scale insects but more damaging to plants under certain conditions than cyanide gas

generated after the other methods commonly used. If this injury factor is neutralized, there is likely to be a further change in the orchard fumigation practice. Calcium cyanide has also been tried out as a dust on various plants. Flint, in Illinois, has done considerable work with it against the Chinch Bug. In California, it is being tried against various pests.

My discussion has been confined to a statement of progress largely as illustrating orchard fumigation. There has been great development in hydrocyanic acid gas fumigation along various other lines. Between 1893 and 1900, cyanide gas was successfully used in treating greenhouses, nursery stock, stored products, mills and other buildings. Each of these methods has experienced great improvement and wider application in recent years. No attempt will be made to detail this progress. More recently railway cars and ships have been fumigated successfully.

The development in 1913–1914 of vacuum fumigation by Sasscer and Hawkins opened an entirely new and highly important field. Vacuum fumigation at once supplied a method of destroying insects in products which no other system of fumigation is able to reach successfully. It has been found to be the system of fumigation under which insect eradication is most certain. Its value in plant quarantine is attested by the number of large vacuum plants at American ports of entry for the treatment of foreign products which might contain insect pests. In California a number of small plants have been installed for treating nursery stock, stored products, et cetera. Vacuum fumigation is assured a great future and its development is proceeding rapidly, especially under the guidance of the Federal Horticultural Board. In California, Mackie of the State Department of Agriculture has made decided progress in the treatment of nursery stock and stored products.

The environment of insects, as well as of plants, at the time of fumigation has a decided influence on efficiency in insect destruction as well as injury to the plant. Valuable data bearing on the influence of various factors, such as wind, temperature, moisture, sunlight, Bordeaux mixture, physiological condition of the plant, have been and are being developed by entomologists and others, thereby increasing the certainty of insect destruction and reducing the hazard to the plant.

THE WHITE SNAIL (*HELIX PISANA*) AT LA JOLLA, CALIFORNIA

By A. J. BASINGER, *University of California*,[1] *Citrus Experiment Station*

ABSTRACT

Helix pisana, a European snail, became established in California and measures were taken to eradicate it. In Europe this snail is a pest of citrus trees. Observations at La Jolla, California, verified this. It is also a possible pest among other cultivated plants. The average number of eggs per individual at La Jolla in December 1922, was 120. This is higher than the number given for Europe. The methods employed in eradication were; clearing the ground of vegetation, flaming the cleared areas, use of poison bait of calcium arsenate and bran, and hand-picking. The results were effective and very few *Helix pisana* are left after one year of eradication work.

The white snail (*Helix pisana*) is a European species, native in Sicily and of considerable economic importance in that country as a pest of orange and lemon trees. The fact that this snail had gained a foothold at La Jolla, San Diego County, California was first brought to the attention of California horticultural officials by Dr. L. O. Howard in 1918. Eradication measures were undertaken at that time which resulted in almost complete extermination (1). Inability, however, to keep up the fight against the snails resulted within a few years in an infestation of such magnitude that there was grave danger of the white snail spreading to the citrus areas of California. The Bureau of Pest Control of the California State Department of Agriculture and the San Diego County Horticultural office, in consultation with the U. S. Department of Agriculture then formulated a cooperative campaign to eradicate the pest. Active operations were commenced on July 17, 1922.

ECONOMIC STATUS OF HELIX PISANA

The economic importance of *Helix pisana* in Europe is given by T. de Stefani (2). He says that the snails feed on the foliage, bark, tender twigs, fruit and blossoms of orange and lemon trees, and on the foliage of almond and olive trees. In La Jolla *pisana* was observed to feed on a great variety of plants, including a small grapefruit tree that was seriously impaired by constant defoliation. In another instance a clump of zinnias in a flower garden made no progress until the snails were destroyed on the premises. The fact that *Helix pisana* feeds voraciously on a variety of plants indicates that it may be a possible pest of crops other than citrus. I have no doubt that it would prove quite damaging to vegetable crops and small fruits as I found it to be fond of the leaves of sweet potatoes, chard, beets and blackberries.

As a nuisance this snail has first rank about a home because it occurs in enormous numbers where conditions are favorable and crawls on and

[1]This paper records the results of work undertaken while the writer was in the employ of the California State Department of Agriculture.

into everything. In La Jolla they became so numerous in places that during the rainy season while the snails were crawling about one could hardly travel on the sidewalk without crunching snails at almost every step.

The Infestation at La Jolla

It is not know how or when *Helix pisana* was first introduced into the United States but one rumor credits a European resident of La Jolla with its introduction for the purposes of a table delicacy. This snail is used extensively as an article of food in France and Italy. It may have escaped from among a collector's specimens, for if taken while sealed with a heavy epiphragm it appears quite lifeless and may, after months, push off the seal and crawl about again. The earliest record of its existence in La Jolla is from some specimens in a collection of shells marked "La Jolla, June, 1914."

When first brought to the attention of the San Diego County Horticultural Office in 1918 the infestation was in the lower end of a canyon that runs through the southern portion of the town, and in a few of the adjoining lots. It covered at that time an area of about three or four city blocks (1). In 1922 the snails had spread throughout the whole length of the canyon and the adjoining properties. They were in twenty-two different city blocks and had a good start also at the Scripps Institution for Biological Research which is about two miles north of La Jolla. In the eradication work it was necessary to treat about eighty acres. This included a margin of safety beyond the actual infestation.

Throughout a large part of the infested area the white snails were present in astonishing numbers. They were on virtually everything—houses, fences, bridges, curbings, trees, telephone poles, shrubbery, weeds and rock piles. In the summer they were sealed fast to the various objects waiting for the rainy season. Only in places that received water regularly was there any action among the white snails in the dry summer. McLean (1) counted 798 snails on a small wild buckwheat bush less than two feet across. In a garden plot 16 by 19½ feet we took out 6690 snails. This was about 21 per square foot and represented a fair average for much of the infested area.

Life History and Habits

Helix pisana is a member of the Pulmonata, a group which comprises the air-breathing Gasteropods. The typical shell is light buff with lineal brown stripes. The variation in shell color ranges, however, from white to buff with no marking of any kind to those having as many as fourteen lineal brown stripes. The usual size of the adult shell is one-half

to three-fourths inch in greatest diameter. The body is light cream to dark gray and in the adult has an extension of one and a half to two inches. As there is no operculum the aperture is sealed with a temporary epiphragm during drought or other unfavorable conditions.

This snail is hermaphroditic and mutual fertilization is necessary for reproduction. Mating begins in the fall when the first rains come and oviposition follows from a few days to several weeks later. At La Jolla mating under natural conditions was first observed November 9 after a good rain had fallen during the night. The first snails were found ovipositing on November 30 after several days of wet weather. When ready to lay eggs the snail digs a hole in the ground about one and a half inches deep and enlarges the lower end to form a cavity for the egg mass. As the genital aperture is at the anterior end the snail does not withdraw its body from the hole until the entire process of digging and egg laying is finished. The soil is dug loose by the lips and jaw and worked out along the lower side of the foot in a flat ribbon onto a little conical pile to one side of the shell. The eggs are deposited singly but adhere to each other as they emerge, forming a mass that looks much like a white blackberry. They are spherical, about two millimeters in diameter and milky white. When through laying eggs the snail withdraws from the hole and carefully closes it at the top with mucus and bits of soil, and then crawls away. The whole process requires several hours. According to T. de Stefani (2) each adult oviposits but once in a season; however, as the generations overlap, egg laying continues from the beginning of wet weather in the fall to the dry season in the spring. He gives the number of eggs deposited by a single individual as from fifty to seventy. At La Jolla in December 1922 the number of eggs in twelve egg-masses ranged from fifty-two to two hundred and twenty-six. The average was one hundred twenty. The number of eggs would no doubt vary according to the age and size of the snail and perhaps also with weather conditions.

The time of hatching, of course, depends on favorable temperature and moisture. In Europe T. de Stefani says it is twelve to sixteen days. At La Jolla it was about three weeks. Eggs laid on the last of November hatched about December 20. The newly hatched snails have a very thin shell of one and a half whorls. The adult snail has five whorls and a fairly hard shell. Shortly after hatching the young begin to feed on the tender plant growth in the vicinity of the nest. Of the snails hatched on December 20 the largest one was about three-eighths of an inch across at the end of fourteen weeks. Besides feeding on nearly all kinds of

green vegetation they also eat such materials as weathered wood, paper and earth.

Methods of Eradication

In eradication work against this pest the first step taken was to clear off all the vegetation, excepting trees, in the canyon and open lots throughout the infested area. Heavy eye hoes were used for this purpose and everything was cut down to the bare ground. It was then worked into piles or windrows where it was left to dry for several days before burning. Leaving the ground bare made an extremely unfavorable condition for the snails, as it reached an uncomfortable temperature during the heat of the day. The disturbance caused by the hoeing stirred the snails into action and many took refuge in the windrows where they were later burned.

Following the clearing of the open areas they were next burned over by a flamer. The outfit for this work consisted of a power sprayer with distillate as the fuel. Nozzles producing a fine spray were mounted on 16-foot iron rods. The distillate was forced through the nozzles and the spray set on fire. The effect was that of an immense blow torch. The flame was played over the ground leaving in its wake a black, barren waste. Of course, some snails under stones and in crevices and other protected places escaped the direct flame and were not killed. However, they were easily picked up later by hand as the disturbance caused them to crawl about and they could be readily located by their slimy trails on the black ground. Two line of hose each seventy-five feet long were operated from the spray rig. This was necessary in order to reach the remote parts of the canyon. Several times it was necessary to join the 75-foot lengths into one in order to flame distant parts.

While the open properties were being cleared and flamed we were carrying on a series of experiments to determine the best means for eradicating the snails from about the many dwellings where we had to deal with lawns, flowers, shrubbery, trees and vegetables. We had no intention of applying the devegetating and flaming process about these places except, possibly, as a last resort. Fortunately our efforts were successful, for in the use of calcium arsenate and bran as a bait we found one of the most effective measures in the fight against *Helix pisana*. This poison bait was adapted from Lovett and Black (3), who used calcium arsenate and chopped lettuce leaves as a control for the gray garden slug in Oregon. We used it in the proportion of one part of calcium arsenate to sixteen parts of bran. It was first mixed dry and then water added until a moist but not wet mash was obtained. Nothing

else was added. It was scattered over the infested area as in sowing grain. Before the winter rains came we were able to get the snails into action by sprinkling the treated areas with garden hose. The snails fed readily under these conditions. During the rainy season the entire infested area was treated twice with the poison, once in the fall and once in the spring. In our trial plot, which consisted of a garden 16 by 19½ feet, we secured in six days a kill of 92.46% of all snails present. There were 6,690 snails in the plot but of this number 259 were still sealed up. This gave us a kill of over 96% of all active snails. The results in our practical applications were fully as satisfactory. It might be well to state here that the brown snail (*Helix aspersa*) also feeds readily on this bait and the poison is highly recommended for that pest.

In spite of the apparent thoroughness with which the clearing, burning, and poisoning were done, it was still necessary to supplement by hand-picking in order to get the few that persisted in remaining sealed up. Hand-picking also had to be resorted to in getting the snails from underneath buildings, from fences, bridges, and other places where we could not use fire or poison.

Progress of the Eradication Campaign

The progress of the eradication campaign at the end of the first year has been such that even the careful observer in La Jolla no longer sees a white snail. A year ago there were millions of them and people came from neighboring towns to see them clustered in great masses on the weeds and shrubbery in the infested area. In the last ten weeks four live white snails have been found by inspectors from the San Diego County Horticultural Office. While the progress has been more than we thought possible in a year it no doubt will take several years of frequent and careful inspections and treatment before the white snail is entirely stamped out at La Jolla.

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Chairman R. E. Campbell: Two papers have been submitted by members who could not be present and will be read by title as follows:

BEES VS. SPRAYING

By R. W. DOANE, *Stanford University*

Much has been said and much written on the subject of bees being poisoned when near-by trees were sprayed while in blossom. Most of these complaints come from the bee-men, themselves, and investigations have sometimes shown that the death of the bees was due to other causes. Several articles written by entomologists and others have, when analyzed, been found to be based entirely on reports made by beekeepers. But Bulletin 247 of the Purdue University Agricultural Experiment Station, published in 1920, contains an interesting account of very definite experiments conducted by W. A. Price, to determine whether the bees could be affected in this way and to determine the amount of arsenic necessary to kill a bee.

Because the results he obtained in these experiments were so very different from a series that I conducted about the same time and in somewhat the same way, it may be of some interest to record the results of my observations.

On April 15, 1919, I sprayed an apple tree that was almost in full bloom with arsenate of lead, using 3 lbs. of the arsenate of lead to 50 gals. of water and using 8 gallons of this spray to the tree. The spray was applied with a pressure of from 150 to 200 lbs., especial effort being made to fill the calyx cups as far as possible. The tree was then covered with a cabinet made of a light wood frame that was covered with a good quality of gauze. In order that there might be sufficient room on each side of the tree the cover was made 18 x 18 x 16 ft. high. The cloth, while fairly firm was light enough so that the activities of the bees inclosed therein, would not be interfered with.

On April 17, in the evening, a moderately strong colony of bees was placed beside the tree under the cover. On the morning of April 18, 2 gallons more of the spray was applied to the tree. This time the spray was applied as a very fine mist, the leaves and petals being well covered in this way. The screen that closed the hive was then removed and the bees were allowed to fly around inside the cover. Within a short time some of them were visiting the blossoms, apparently feeding; before noon scores of them were feeding freely. A number of the bees flew directly to the top of the cabinet and tried to escape and during the whole course of the experiment some bees were to be seen along the upper corners trying to get out. On the morning of the 19th the bees that had remained outside of the hive over night were chilled and not able to fly. Some of them had dropped to the ground and were crawling

about feebly, but very few dead ones were found. During that day and the following day the bees were watched carefully and their activities seemed to be perfectly normal. At the end of the second day the bees were taken back to the apiary from whence they came. About 125 dead bees were found inside the cabinet and 65 live bees that had not found their way back to the hive, were also collected. These were placed in separate vials to be submitted to a chemist for analysis to determine whether they would show any traces of arsenic.

On the afternoon of April 21 with the owner of the bees, I made an examination of the colony that had been returned to the apiary. We found them working in an apparently normal way and we found that they had been storing honey during the two days that they were in the cabinet. All of the larvae seemed to be in normal condition; a number of cells were open and it is to be presumed that the larvae were being fed during the time of the experiment, otherwise they would have died. The queen had been laying eggs, and there was nothing about the colony to suggest any unusual conditions. I may add here that this colony was observed from time to time during the following year and no unusual conditions were noted.

On April 22, in order to check the first experiment the cabinet was placed over another tree near the one that had been sprayed for the first experiment. This tree was about the same size and shape and in about the same condition as regards blossoming as the tree used in the experiment. We then selected another colony of bees that corresponded as nearly as possible in every way to the colony that had been placed under the cabinet in the first experiment. This colony was placed under the cabinet with the tree that had not been sprayed and their behavior carefully noted. The first ones that came out flew about uneasily for awhile, many of them flying to the top of the cover where some of them stayed. Many of them soon began to feed on the blossoms and in a short time they were feeding in a perfectly normal way. In the evening it was noted that a number were still clinging to the top of the cover, a few were found dead on the ground, and a few were crawling about in the grass. There was some brown spotting on the top of the hive and on a strip of cardboard placed on the ground in front of the hive; similar spots to these were seen during the progress of the first experiment, and there seems to be nothing abnormal about these spots. The number we found is doubtless due to the fact that the bees could not fly far away and any droppings from them would, therefore, be more numerous in the inclosed space and so more conspicuous.

The bees were under observation until noon the next day. During this time the bees in this check experiment behaved in the same way as the bees that were used in the first experiment. All the dead bees that could be found were then gathered up and placed in a vial in order that they might be submitted to the chemist for analysis, to check the analysis made on the bees taken from the cabinet when it was over the tree that had been sprayed.

When the chemist submitted his report after he had analyzed these bees, it was found that the dead bees that were collected in the cabinet at the end of the first experiment, contained .00000255 grams of arsenic per bee. The bees that were collected while they were still alive during the first experiment, showed .000002 grams per bee. The bees that were found dead in the cabinet when it was used for the check, contained .0000006 grams of arsenic per bee.

In making these tests the bees were counted and weighed and then placed in beakers and digested with nitric acid followed by sulphuric acid. The arsenic was then determined by the well known Gutzeit method, a blank on the chemicals was run with the samples.

These analyses showed that the difference between the content of arsenic in the bees that were exposed to the arsenic and those that were not exposed, was so minute as to be inconsiderable.

It must be remembered that all plant and animal substances contain quantities of arsenic, so that careful analysis made at any time will always show a trace.

In the spring of 1920 I began another series of experiments in which I sprayed the trees while they were in full bloom in order that I might test the effect of such a spraying on bees and thus check up the experiments conducted in 1919. On April 12, 1920, two apple trees were sprayed with arsenate of lead, using 6 lbs. of arsenate of lead to 50 gals. of water. About 5 gallons of the spray was applied to each tree and care was taken to drive the spray into the calyx cups as much as possible. As there was a little mildew on these trees some atomic sulphur was used in the spray. Many of the blossoms on one of the trees were gone; the other tree had at least half of the blossoms on it and a number of bees were visiting the blossoms evidently feeding. In another part of the yard a pear tree, which was in full bloom, was sprayed with the same material. As this was a small tree all of the blossoms were easily available and it was given a good thorough spraying.

On an adjoining lot was a hive of bees, situated about 25 ft. from the

pear tree and about 100 ft. from the apple trees that were sprayed. The bees that were feeding on the trees at the time the spraying was done were passing to and fro from this hive. On April 19 the same trees were sprayed again; on this day I used dry acid arsenate of lead at the rate of 4 lbs. to 50 gals. of water, and added to this dry Bordeaux mixture, using the latter at the rate of 6 lbs. to 50 gals. of water. There were still a few blossoms on one of the apple trees and many on the pear tree. During the interval between April 12 and 19 I had an opportunity to watch the bees as they were coming from and returning to the hive on the lot near the sprayed trees. As far as I could determine they were in normal condition.

On April 17 I placed a hive with a fairly strong colony of bees in it, under one of the apple trees on an adjoining lot where there were five or six apple trees blooming. The hive was kept closed for 24 hours and when it was opened in the evening a great many bees came flying out but within an hour most of them had reentered the hive or had settled on it close to the entrance. The next day a number of dead bees were found on the canvas that was spread in front of the hive. These were all brushed away; I found later that some dead bees were still being carried out; these bees had doubtless died because the hive was closed for such a long time. On April 19 I selected two of the trees that were closest to the hive and gave them a very thorough spraying with arsenate of lead, using 6 lbs. of arsenate of lead to 50 gals. of water, and applying 5 gallons of the spray to each tree. These trees were in full bloom, a few of the petals were just beginning to fall. Care was taken to drive the spray into the calyx cups as much as possible. A third tree which was much larger and which was just coming into full bloom, was sprayed with dry acid arsenate of lead, using 4 lbs. of the arsenate of lead to 50 gals. of water. About half of this tree was sprayed with the coarse spray, an attempt being made to drive the spray into the calyx cup as usual. The other half was sprayed with a fine mist, an attempt being made to cover all of the blossoms and the leaves with this fine mist. The spraying was continued until it appeared that the leaves were covered with all of the material they would hold without dripping.

When I began spraying, the bees from the hive were feeding on the blossoms in great numbers; most of them were driven away by spray material but within ten minutes of the time the spraying was stopped, a number of them were back on the tree again, so their feeding was interrupted for only a short period. The day was sunny and fairly warm although a slight breeze was blowing intermittently. This work was

done with a small hand-power spray pump and a pressure of 150 to 175 lbs. was maintained. During the next ten days I watched the bees and the trees very carefully and then took the colony back to the apiary from whence it came. During the time that the bees were in the orchard no unusual conditions developed. The bees had been working actively and while a few dead bees had from time to time been found on the cloth spread outside of the hive, the number had not been more than one would expect to find around a hive at this time of the year. An examination of the hive at intervals after it was returned to the apiary showed that the bees and the brood were in good condition and that the bees had stored a good deal of honey during the time they fed in the small apple orchard.

It is a common practice among the bee men of Santa Clara Valley to lease their bees to orchardists for the blossom period, some orchardists paying as high as $2.00 or even $3.00 a colony to have the hives placed in various parts of their orchards. No restrictions are made as regards spraying and it is a well known fact that California orchardists are enthusiastic sprayers. One prominent bee-man told me that when he first began this practice of renting his bees for use in the orchards he feared that he might lose some of them when the trees were being sprayed as he had heard that bees were sometimes poisoned in this way. But as year after year went by and he noted no bad results from having his bees in orchards where they were spraying with arsenical and other sprays, he came to pay no attention to it at all.

In the Pajaro Valley, one of our important apple-growing sections, the orchardists begin to spray very soon after the apple blossoms appear and continue to spray for several weeks so the bees have every opportunity to feed on sprayed blossoms over a long period, yet we do not have any reports of spray injury to bees in that section.

A real California booster would say "It's the climate!" Possibly it is.

SOME ASPECTS OF BIOLOGICAL CONTROL IN HAWAII

By D. T. Fullaway, *Entomologist, Hawaiian Board of Agriculture and Forestry*

The use of natural agencies for keeping insect multiplication within bounds, which the term "biological control" connotes, has proved a most successful method of dealing with injurious insects in the Hawaiian Islands, and has been of great economic value. Artificial methods of control, on the other hand, have given generally poor results. The reason of this is found in peculiar conditions here, which I shall attempt to describe.

Nearly all of our pests are immigrant species, and many of them have become established in Hawaii without the checks upon their multiplication which exist in the lands from whence they came. The climate here also is conducive to the rapid multiplication of insects. The temperature rarely falls below 60 degrees Fahrenheit in the lowlands. Hence, it is possible for the development of insects to go on without interruption, and six to eight cycles annually is not unusual for many species. Hibernation phenomena are scarcely discernible. Again, a luxuriant vegetable growth furnishes an ample supply of good.

In these circumstances, adaptable species reach excessive numbers in a very short time, occupy the land to the extent of available food, and generally become a scourge on improved land. Artificial methods of control are inadequate to the situation, usually not giving the desired results and involving excessive expenditure to get even poor results.

On the other hand, all the conditions cited as favorable to the excessive multiplication and rapid dissemination of injurious forms, likewise favor the use of natural agencies for their restraint. The introduction of beneficial insects can be undertaken at any time of the year, their propagation and colonization are greatly facilitated by the abundance of host material and the absence of a dormant season, which in more northern latitudes often seriously hampers biological work. The peculiar nature of our insular fauna is also a favorable circumstance here, the paucity of forms operating to make the incidence of hyperparasitism less likely.

Finally, the character of our agriculture is also a favorable circumstance. I mean to say that the bulk of our production is limited to a comparatively few crops, grown under field conditions over large areas, and the business of production is highly organized. These features all work advantageously. In the first place, the limited scope of the work makes it a possibility as far as the time element is concerned. Secondly, centralized management and adequate support are essential to expensive work involving a high degree of technical skill and sustained effort. Thirdly, the effect of a small improvement is rendered disproportionately great when the application of it is extensive.

In stating that our work along the lines of biological control has been successful, I do not wish to be understood to imply that the success has been uniform in degree or that the establishment of a beneficial species has succeeded from every introduction made. Quite the contrary has been the case. The consignments received from our collectors which have produced results are few in number when compared with the total

number of consignments made, and the results have varied to a very high degree, from the perfectly satisfactory control of *Anomala orientalis*, achieved through the introduction and establishment of a single enemy, *Scolia manilae*, to the fruitless search for wire worm enemies, which has extended over four years. An entirely satisfactory control of the sugar cane leaf hopper has only been achieved after twenty years' work, involving the introduction of more than a score of enemies. The control of the Mediterranean fruit fly has not been entirely satisfactory owing to the fact that the larvae occur in many fruits with a thick pulp, where the parasites which are effective to a high degree in thin-pulped fruits, cannot reach them. Recent introductions to improve the control of the avocado mealy bug, *Pseudococcus nipae*, have given marvellous results in a very short time, but in the case of other coccid species the control exerted by parasites and predators has been less marked.

A perplexing question in our experience with this work has been, Should all the obtainable enemies of an injurious species be introduced or should a complex be avoided and dependence put upon one effective enemy. I believe this, in the light of our experience, is still a debatable question.

I realize that in this hasty survey of the subject I have only skimmed its surface, but I have been warned of a time limit. In conclusion I would add that if the application of this method to the subjugation of an insect pest does not always result in a full and complete control of the pest, it at least often brings its multiplication within such bounds that artificial methods can be used with some degree of satisfaction. Also, that the main defect of the method from a practical standpoint appears to be its limited application.

Afternoon Session, September 19, 1923

R. E. CAMPBELL, *Chairman*

JOINT MEETING WITH ECOLOGISTS, PLANT PATHOLOGISTS AND PLANT PHYSIOLOGISTS

SUBJECT: Ecological Factors Influencing Distribution and Severity of Insect Pests and Plant Diseases.

Papers were presented by H. S. Fawcett and E. T. Bartholomew, and afterwards discussed by the members present.

A telegram was sent to the members whose homes were burned in the Berkeley fire and included W. B. Herms, H. H. P. Severin and Dr. E. C. Van Dyke, all of the Entomology Division, University of California.

The meeting was adjourned to meet next year with the Pacific Division of the American Association of Economic Entomologists at the place to be announced later.

A SIMPLIFIED METHOD FOR MAKING LUBRICATING OIL EMULSIONS[1]

By A. M. BURROUGHS and W. M. GRUBE, *University of Missouri, Columbia, Missouri*

ABSTRACT

A method is described by which stock emulsions of paraffin oils used in spraying are made without heat and without the use of potash fish-oil soap. Freshly made bordeaux mixture or copperas-lime mixture, calcium caseinate, saponin and other substances were used as emulsifying agents in the place of soap. The oil, water and emulsifying agent were placed together in a container and pumped twice under fairly high pressure. The emulsions made in this way were used successfully on a large scale. They gave as good results against San Jose scale as the emulsions made with potash fish-oil soap, and were cheaper and easier to prepare. These emulsions did not break down in the presence of hard water or water contaminated with lime or lime-sulphur.

In the past few years there has been a marked increase in injury to apple trees from San Jose Scale in northern Arkansas, southern Missouri, and southern Illinois. The standard dormant spray of strong lime-sulfur solution has failed to give control in some cases. In an effort to control scale more cheaply and efficiently, the Bureau of Entomology of the United States Department of Agriculture tried out the lubricating oil emulsions used against citrus scale in Florida. Experiments carried out by Ackermann[2] at Bentonville, Arkansas, in 1921–22, indicated that a 2% emulsion of engine oil was effective against San Jose Scale on apple trees. As a result of his work, a large number of orchards in Arkansas, Missouri, and Illinois have received dormant applications of this spray during the spring of 1923.

The formula and methods for preparing the emulsion are given by Yothers[3] and Quaintance.[2] This is generally known as the "Government Formula" and is given below:—

Engine Oil	2 gal.
Potash Fishoil Soap	2 lbs.
Water	1 gal.

The oil and the solution of soap in the water are mixed and heated to the boiling point, and pumped twice through a pump giving 60 lbs. pressure. Further directions and details are given in the publications referred to above. This method has given good results at the Missouri

[1]Contribution from the Departments of Horticulture and Entomology, University of Missouri. The authors wish to express their appreciation of the advice and help received from the members of these two departments, and especially from Mr. O. C. McBride of the Dept. of Entomology.

[2]U. S. Dept. of Agriculture Clip Sheet 193, 1922.

[3]U. S. Dept. Agriculture Farmers Bulletin 933, 1918.

Experiment Station, and has been successfully used by many growers in the State. Other growers have had trouble in getting good emulsions. Emulsions made according to the Government Formula have been put on the market by spray companies, and in some cases the growers have been advised to buy these rather than make their own.

It has been stated that the oil-soap stock emulsion made according to the Government Formula contains $66\frac{2}{3}\%$ oil. This is not the case. To make stock emulsions containing $66\frac{2}{3}\%$ oil by volume, the following formula has been used here:—

Engine Oil	2 gal.
Potash Fishoil Soap	2 lbs. (about 1 qt.)
Water to make total of	3 gal. (about 3 qt.)

We have been able to make good emulsions using $1\frac{1}{2}$ lb. of soap instead of 2 lbs. as in the above formula. These stock emulsions of oil and soap, containing 59–67% oil, mix freely with soft water, and are added to a tank of water in proper proportions. However, if mixed with hard water, lime-sulphur, or any mixture containing an appreciable number of calcium ions, spontaneous de-emulsification occurs. This is due to a reaction between calcium and the potassium soap, with the formation of a calcium soap. A calcium soap tends to stabilize emulsions of water in oil, rather than of oil in water. Under working conditions, however, de-emulsification occurs rather than a change of phase. Oil-soap emulsions can be "stabilized" for use with hard water and lime-sulphur, by the addition of glue, casein, flour, starch, etc.[3] A ½-½-50 Bordeaux mixture has been widely utilzed as a stabilizer when hard water has to be used.

Following the work of Pickering,[4] emulsions have been made up at the Missouri Agricultural Experiment Station in the cold, using Bordeaux mixture, and a mixture of ferrous sulphate and lime as emulsifying agents. Calcium caseinate, sold under the trade name of "Kayso" has also been used successfully as an emulsifying agent, as well as powdered saponin and extract of soap bark. Such emulsions have been made up in considerable quantity, and used in spraying over 300 bearing trees. No statement can be made in this article as to the expediency of replacing lime-sulphur by oil emulsions for the dormant spray. However, the success attained in preparing and applying these emulsions, it is believed, warrants the presentation of the method of preparation. A comparison of the results obtained with such emulsions and those made according to the Government Formula is also given.

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[4]Journal Chemical Soc. 91: 2001, 1907.

The engine oils used in Florida are residual oils, with a specific gravity of around .90. They boil between 300° C. and 400° C. The brands of oil used in this work were "Paraffin Diamond" and "Red Engine Oil," purchased from the Standard Oil Company of Missouri. Paraffin Diamond is the type of oil used in oiling floors. Red Engine is somewhat heavier, and is used as a cheap, low quality lubricant. When using what he called finely divided solids as emulsifying agents, Pickering used "solar distillate "a residual oil boiling between 240° C, and 350° C, and having a specific gravity of .858. In many respects, this resembled the paraffin oils used recently in the United States.

In Pickering's work, Bordeaux mixture, or ferrous sulphate-lime mixture was made up according to the Woburn formula; that is, with no excess lime present. The desired percentage of oil was added directly and the mixture emulsified by pumping it back on itself by means of a "garden syringe." We have made stock emulsions by a number of formulas. Four of the most satisfactory ones are given below:—

Formula No. 1		Formula No. 2	
Engine Oil	2 gal.	Engine Oil	1 gal.
Tap Water	1 gal.	Tap Water	1 gal.
Copper sulphate	¼ lb.	Copper Sulphate	½ lb.
or		or	
Ferrous Sulphate	¼ lb.	Ferrous Sulphate	½ lb.
Quick Lime	¼ lb.	Quick Lime	½ lb.
Formula No. 3		**Formula No. 4**	
Engine Oil	2 gal.	Engine Oil	2 gal.
Water	1 gal.	Water	1 gal.
Kayso	4 oz.	Saponin	4 oz.
		(or extract from ½ lb. soap bark.)	

To make the emulsions with Bordeaux or iron sulphate-lime mixture, add to the oil the required amount of the metal salt, dissolved in one-half the water required, and add the lime in suspension in the remainder of the water. Mix a little, then pump the mixture into another receptacle by means of a bucket pump. A Bordeaux nozzle adjusted to give a fine spray is desirable. To make emulsions by means of Kayso, suspend it in water, add it to the oil, and pump as before. The Kayso is best wetted by adding water slowly and stirring, until a paste or dough is formed, then diluting until the required amount of water is present. When saponin is used it is merely stirred up in the water, the oil added, and the mixture pumped back and forth.

Other methods or formulas in preparing the emulsions may give equally as good results. Considerable force must be used in the pumping. We generally pump the emulsion at least twice. If Bordeaux or iron sulphate-lime mixture is used as an emulsifying agent, it must be freshly made. Bordeaux is useless for the purpose after it has stood

for a short time. These stock emulsions can be made by means of a power sprayer. The ingredients are put in a half barrel or other container and the suction hose and a hose from the return line placed in the container. The mixture is then pumped from one receptacle to another until emulsified.

The emulsions made in the manner described above have larger oil globules than the oil-soap emulsions. Those made by means of the basic metal hydroxides have a tendency for a little oil to separate out after a time. This can be emulsified again by re-pumping. The emulsions so made do not separate spontaneously in the presence of hard water, lime-sulphur, or in containers contaminated with lime or lime-sulphur, as do the soap emulsions.

When diluted with water, the emulsions tend to rise to the top, but can be kept properly mixed by the degree of agitation obtained in a power sprayer. By emulsifying the oil with a relatively large amount of Bordeaux or iron sulphate-lime mixture, an emulsion can be made which is heavier than water, and which can be more easily kept stirred by the agitators. If the right proportions are used, an emulsion with a specific gravity of 1 can be made. Pickering[4] gives the formula for such an emulsion of solar distillate.

Pickering believed that, where the so-called insoluble emulsifiers were used, the oil globules were surrounded by minute solid particles of the emulsifier. Text books,[5 6 7] give other explanations of the action of emulsifying agents in general, but most of them mention that Pickering's emulsions are exceptions to the general rule.

Holmes[5] describes the ideal emulsifying agent as a solvated colloid giving a tough elastic film, gelatinous and swollen on the side of the continuous phase (water) and coagulated and slightly wetted on the side of the dispersed liquid (oil). The proteins, alkali soaps, and the other hydrated colloids which can act as emulsifying agents for engine oils, fulfil the requirements of this theory. Holmes evidently believes that the emulsions made with Bordeaux mixture differ from those having hydrated colloids as emulsifiers. Yet Duggar and Bonns[8] consider dried Bordeaux films to be capable of hydration. Colloidal metal hydroxides are able to hold in combination a large amount of water. Clay was one of Pickering's "solid emulsifiers," yet under some conditions, clays are highly hydrated. It may be that the basic sul-

[5]Holmes, N. H. Laboratory Manual of Colloid Chemistry. N. Y., 1922.
[6]Bancroft, W. D. Applied Colloid Chemistry, N. Y., 1921.
[7]Clayton, W. The theory of Emulsions and Emulsification. Philadelphia, 1923.
[8]Annals of Mo. Botanical Garden, 5: 153, 1918.

phates of iron and copper, when freshly prepared, act as hydrated colloids, and fulfill the requirements of a good emulsifying agent, as given by Holmes. Pickering obtained good emulsions with solid emulsifiers only when they were freshly prepared and in the medium in which they had been precipitated. He failed to get satisfactory emulsification with previously dried materials, even when they were very finely divided. In the light of the modern conception of the colloid condition as a state in which any substance may exist, it seems unnecessary to make an exception of Pickering's emulsions.

It has been stated[9] that oil-soap emulsions should not be used with Bordeaux, due to change of phase and liberation of free oil. We have seen no signs of such liberation of oil when the soap emulsions are added to freshly prepared Bordeaux. A ½–½–50 Bordeaux mixture has been widely used as a stabilizer when oil-soap emulsions are to be used with hard water. Other substances, such as starch, flour, glue, casein, and calcium caseinate, which are used to stabilize oil-soap emulsions in the presence of the calcium ion, can be used as emulsifying agents. It seems probable that the so-called stabilizing material forms a film around any unprotected oil particle present. These oil particles may be gotten into the presence of the hydrophile colloid chemically, by destruction of the soap film, or mechanically, by breaking up by means of a spray.

The reason why only freshly prepared Bordeaux mixture is efficient as an emulsifying agent is somewhat obscure. This property is probably dependant on the degree of dispersion of the basic copper sulphate. Coagulation goes on rapidly in Bordeaux, due to the presence of two flocculating agents, lime and gypsum. If Pickering's views are correct, it may be the increased size of the particles which prevents their acting as an emulsifying agent. If we assume that the Bordeaux acts as a solvated colloid, the decrease in hydration due to coagulation may prevent emulsification. A parallel to the latter hypothesis exists in the case of skim milk. Fresh skim milk makes good emulsions for a time, but clabbered skim milk, where the casein has coagulated and become less hydrated, is not a satisfactory emulsifying agent.

It is not within the scope of this paper to discuss the advisability of replacing lime-sulphur with engine oil emulsion as a scale spray. It may be said, however, that in the Middle West 2% engine oil emulsified according to the Government Formula, is considered to be an efficient

[9]Mahin, E. G. and Carr, R. H. Quantitative Agricultural Analysis, New York, 923.

scalecide. Comparisons have been made of emulsions made according to various methods, as to control of San Jose Scale and the grain aphis. The results are given in the following tables:—

TABLE I. EFFECT ON SAN JOSE SCALE OF 2% DIAMOND PARAFFIN OIL EMULSIFIED BY VARIOUS METHODS

Emulsifying Agent	*Number Counted*	*Percentage Killed*
Potash Fish oil Soap	815	96.2%
Kayso	1168	97.8%
Saponin	1043	98.5%
Bordeaux Mixture	1317	95.7%

TABLE II. EFFECT ON THE GRAIN APHIS OF 2% DIAMOND PARAFFIN OIL APPLIED IN THE DELAYED DORMANT STAGE. (UNDER LABORATORY CONDITIONS).

Emulsifying Agent	*Number Counted*	*Percentage Killed*
Potash Fish oil Soap	316	92.0%
Kayso	287	96.2%
Bordeaux Mixture	941	90.0%

These counts give evidence that the efficiency of the oil is little affected by the nature of the emulsifying agent. The emulsions of oil with Bordeaux, Kayso and saponin seem to have been as effective as emulsions made according to the government formula. The differences in the percentage of control are probably due to experimental error. The degree of control of aphis under field conditions varied with the time of the application and care used in spraying. In one case, 2% oil-Bordeaux emulsion was applied in a heavily infested orchard when the buds were just opening and the aphids were clustered on the green tips of the buds. Under these conditions 96% control was obtained. The results against the grain aphis suggest that the cold emulsions might be a valuable means of control of more serious aphis pests.

The emulsions made according to methods given above promise to be as valuable as the oil-soap emulsions, and are somewhat cheaper and easier to prepare. One hundred gallons of 2% oil emulsion cost from 34c to 48c depending upon the emulsifying agent used. Bordeaux and iron sulphate-lime emulsions are the cheapest. Not having any soap in their composition, they are compatible with Bordeaux, lime-sulphur and lead arsenate, and can be used with hard water.

A REFRIGERATOR FOR SHIPPING LIVE INSECTS[1]

By JOHN N. SUMMERS

The satisfactory shipping of imported parasites of the gipsy moth from the countries where they are obtained to the United States Bureau

[1]Mr. A. F. Burgess suggested the ice cream shipping tub as being best adapted to our needs.

of Entomology Laboratory at Melrose Highlands, Mass., has long been attended with considerable difficulty. With those species which can be obtained safely in the hibernating stage the problem is comparatively simple, but with others the summer broods have to be collected as either they use hibernating hosts which would be dangerous to import or they can only be obtained in satisfactory numbers during the summer. Some of these species may be handled best by collecting and shipping the parasitized gipsy moth larvae while with others we collect the cocoons or the puparia. To insure safe arrival the host larvae must be kept alive until the parasites issue and the parasite adults must be prevented from emerging en route. In either case refrigeration is necessary for without it the host larvae will only live for a short time and as the pupal stage of the summer broods of parasites is short, the adults will emerge and die long before they reach their destination.

The successful importation of parasites is therefore dependent upon proper refrigeration en route. This can be obtained for the trans-oceanic part of the route by having the boxes placed in the cold storage rooms of the vessels, but no such facilities are available on land. Our difficulty lay in getting suitable refrigeration for long overland shipping, particularly for the shipments of parasites which were sent from Japan. As speed was a vital factor, all such shipments were sent by express. Although the company handles considerable amounts of perishable produce it does not own any small refrigerators as all of these belong to the individual shippers. At times it is possible for the company to borrow one of these small refrigerators but it is not certain that one will be available when needed. Therefore we were compelled to secure some of our own to insure that they would be at hand to receive our shipments.

Information about the various types of small refrigerators in use was obtained. Of these, the type used in shipping ice cream appeared to be the best for our purposes. Its weight when iced was not excessive and as it is in general use express employees are familiar with it and would be almost certain to give one the proper attention. We had to avoid the danger of having the water from the melting ice penetrate to the parasites, which might result if the refrigerators were placed in any position but upright. With the ice cream shipping tubs there would be small danger of this owing to their shape and to the fact that they are familiar objects.

Refrigerators of a ten gallon capacity were obtained, these consisted of heavy metal cans eleven inches in diameter and twenty-four inches

high enclosed in heavy wooden tubs. These tubs were thirty inches high, nineteen inches in diameter at the bottom and twenty-one inches

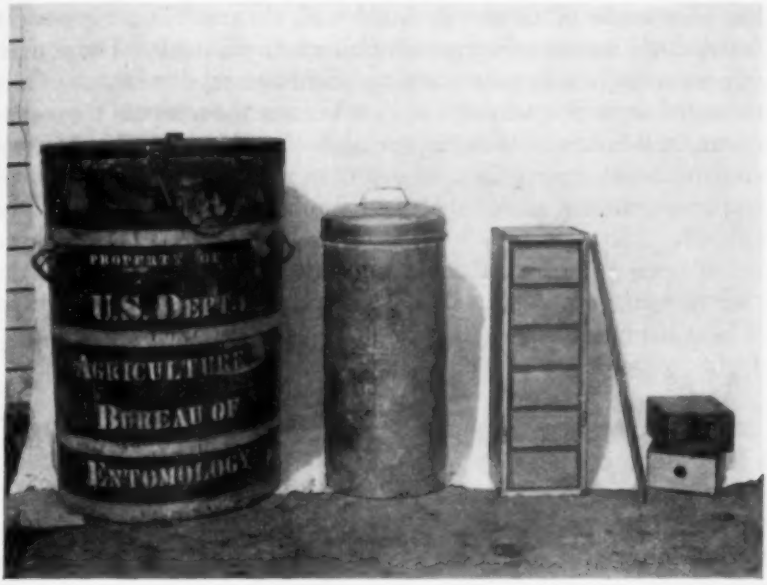

Fig. 6—Component Parts of Refrigerator and Shipping Box (Photo by Hood)

in diameter at the top. The tubs did not possess covers so they were fitted to heavy wooden ones which were padded around the edge to make them as tight as possible and prevent the rapid melting of the ice and the escape of the cold air. To the center of each cover on the inside a small padded wooden block was attached which pressed down on the handle of the can cover to keep the latter securely in place. To prevent the can being thrown around inside and insure an even layer of ice around it, it was held centered at the bottom by three or four small wooden blocks and at the top by a pair of iron straps which were attached to the tub at the sides and were tightened around the can by means of two bolts.

When the tubs were purchased there were vents in them which would allow the water to drain off. These were plugged so that the water would remain until the refrigerators were re-iced, as it would remain cold for some time and prevent the warming up of the contents.

The boxes in which the parasites were to be shipped were of the same type which has been found to be so satisfactory for this purpose, i. e.

a number of light wooden ones enclosed in a heavier wooden box and, of a size to fit the metal containers of the refrigerators. The large boxes were constructed of half inch stock and measured 7½ x 7½ x 22¾ inches. Each one of these was fitted with six small boxes measuring 3½ x 6½ x 6½ inches, constructed of quarter inch stock. For convenience in removing the parasites and to guard against the escape of any, which might occur if it was necessary to remove the covers of these small boxes, an inch hole was bored in one side of each one. This hole was covered by tacking over it a square of tin which could be removed for the insertion of a glass tube when the shipment arrived.

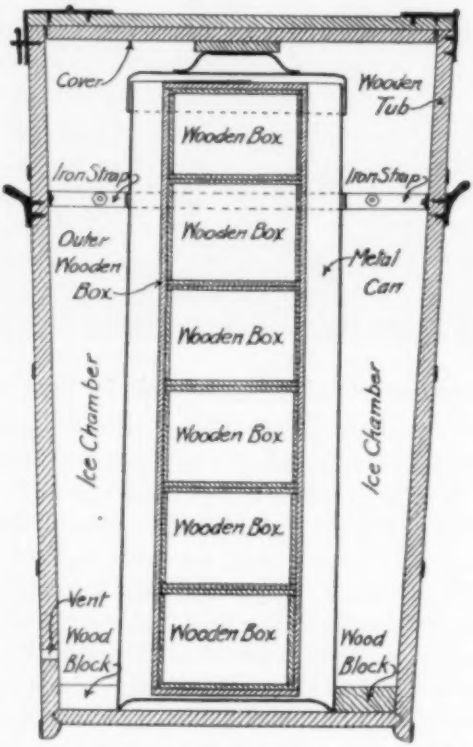

Fig. 7—Diagram of Refrigerator and Shipping Box Assembled (By Guild)

The refrigerators received a very good testing the past summer from a shipment of *Apanteles fulvipes* from Japan. This species is a difficult one to ship over a long distance as its cocoon stage is only about six days, which makes proper refrigeration absolutely necessary. Boxes for shipment were constructed in Japan. Two of these were packed with

parasitized gipsy moth larvae when the first *Apanteles* larvae were beginning to issue, and shipped from Yokohama on May 19, in the cold storage room of one of the fast Trans-Pacific vessels. The boxes arrived at Seattle May 29 and were placed immediately in two of our refrigerators which were on the dock all iced ready to receive them. As the refrigerators were cold there was no opportunity for the parasites to suffer from a rise in temperature. The two refrigerators were immediately started for Melrose Highlands and were re-iced once en route. The shipment arrived at our Laboratory June 5, having taken eighteen days from Japan. On arrival the shipment was unpacked immediately. All of the ice had melted but the water was very cold. About five per cent of the host larvae were alive and active. The parasite larvae had issued from their hosts and spun their cocoons but none of the adults had emerged. *Apanteles* adults began to emerge shortly after arrival and continued for several days, every cocoon producing a vigorous adult.

The refrigerators were also tested for the shipment of live larvae. A collection of web worm larvae, *Hyphantria* sp., was made at Seattle, packed in one set of boxes and shipped August 11, to Melrose Highlands in one of the refrigerators, taking seven days to reach there, being re-iced once en route. The shipment was in good condition on arrival with about half of the larvae alive and vigorous. Results were very good considering the fact that it was not possible, owing to limited facilities, to exercise quite the care in packing necessary to get the best results.

Much of the success of such shipments depends upon the care used in packing. When parasitized larvae are sent too many must not be placed in each box; with the gipsy moth we pack from fifty to a hundred, depending upon their size, and plenty of small branches of foliage must be included. The foliage serves two purposes,—it provides food for the larvae, and prevents them from being thrown against the sides of the box and injured. If parasite cocoons or puparia are sent it is usually best to pack these in layers separated by sheets of paper but some experimenting may be necessary to determine the best way.

The small boxes should be lined with blotting paper to absorb the moisture precipitated when the temperature is lowered otherwise there will be an excess of moisture and the growth of mold.

The illustrations were made by Messrs. C. E. Hood and I. T. Guild of the Gipsy Moth Parasite Laboratory, and the method of holding the can in place devised by Mr. H. I. Winchester.

THE PINK BOLLWORM OF THURBERIA, *THURBERIPHAGA CATALINA*

By J. L. WEBB, *Entomologist, Southern Field Crop Insect Investigations, Bureau of Entomology, Department of Agriculture*

ABSTRACT

The pink boll worm of *Thurberia* constitutes a great menace to the cotton grown in the valleys of Arizona below the range of *Thurberia*. An account of the rearing of the adult is given, including notes on parasites of the larval stage. A list of other *Thurberia* insects collected by C. H. T. Townsend is also included.

During the summer of 1913, Dr. W. D. Pierce and Dr. A. W. Morrill made an investigation of the insects associated with the Thurberia plant in several localities in Arizona. In their published report[1] they make mention of "the Thurberia Boll Worm" and give brief descriptions of all stages except the adult which was at that time unknown.

In December of the same year, E. A. Schwarz and H. S. Barber investigated the status of the Thurberia plant and the newly discovered Thurberia boll weevil, *Anthonomus grandis thurberiae* in the mountains of southern Arizona.

Besides the weevil they found abundant evidence of the infestation of Thurberia bolls by a species of bollworm which they called the "pink bollworm." Both these men expressed the view that the pink boll worm (of Thurberia) constituted a greater menace to the cotton grown in the valleys below the range of Thurberia than did the Thurberia boll weevil.

In August 1918 Dr. C. H. T. Townsend was sent by the Bureau of Entomology to the Santa Catalina mountains near Tucson, Arizona, for the purpose of rearing the adult form. His report follows:

"Permanent camp was made August 14, 1918, in the upper end of Sabino Basin, Altitude 3,550 ft. This camp was well situated for the work, being surrounded by Thurberia not only close by but also in all directions at both higher and lower levels. The plant was noted from 3,000 ft. up to 4,800 ft. in Sabino Canyon and around the sides of the Sabino Basin. Above 4,800 ft. it was not found anywhere, the pinyon beginning at that level. The altitudes were taken by aneroid.

PINK BOLLWORM OF THURBERIA.

Four hundred forty infested bolls were collected from August 28 to October 4, the bulk of these being found during the last two weeks of September. Not counting a number of worms that escaped from time to time from the rearing receptacles, 142 bollworms were secured from these bolls.

Twenty-two of these worms transformed to pupae in the earth. These were taken with great care from the earth October 13 and packed in cotton in vials for transportation to Washington.

The 142 bollworms yielded 41 hymenopterous parasites, belonging to at least 3 species as follows:

[1]Washington Ent. Soc. Vol. xvi, pp. 14–23.

Apanteles[2] n. sp	32
Microbracon n. sp	7
Perisierola n. sp	1
Microhymenopter undet	1
Total hymenopt. parasitism	41

The above is a parasitism of nearly 29%.

In addition to this parasitism, which may yet be increased by muscoid parasites issuing later from the pupae, from 5% to 10% of the infested bolls containing worms are opened by the Southwestern jay, *Aphelocoma* sp., probably the form known as *Sieberi arizonae* Ridgway.

Thus some 35% of the worms appear to be destroyed by natural enemies in the Sabino Basin region, at the least estimate, or well over one-third.

The 22 pupae will, I hope, yield the adult this season, so that the species may be identified. A single specimen of a moth found in one of the insectaries, which had crawled in during the night and may have been attracted by the odor from the Thurberia bolls, was determined by Dr. Dyar as *Perigea continens* Edw. It is a noctuid and about the right size for the Thurberia bollworm moth, but may have nothing to do with it.

The worms in the bolls were extensively attacked, both dead and alive, by two or more species of Phorids while in the insectaries. These phorids are attracted to all fermenting substances, and the frass from many worms assembled in small space is probably the cause of their appearance in great numbers in the rearing receptacles. They accounted for the large mortality in the worms. If the receptacles were covered tightly enough to exclude them, the air was also excluded. As they were not met with in the bolls in the open, they are not taken into account as a control factor.

Other Thurberia Insects

Anthonomus thurberiae Pierce—Found frequently in all stages.

Dichomeris deflecta Busck—Many evidences found during August.

Inglisia malvacearum Ckll.—This scale was found in abundance on two plants at 3,550 and 3,800 ft.

Cecid leaf-gall—Very abundant about the first of September.

Thyanta perditor Fab.—Adult found sucking green boll at 4,100 ft.

Sphyrocoris 2 n. spp.—Nymphs found sucking green bolls at 3,800–4000 ft.

Formica fusca guava Buckley—A perfectly constant attendant on the Thurberia plants everywhere. No plants found without them. I did not see the species elsewhere.

Eriophyes sp.—Bad infestation of plants in patches at 3,500–4,000 ft.

Acridiid sp.—Greenish-yellow nymphs found on Thurberia on half dozen occasions at about 3,500 ft. Not seen elsewhere.

Many bees and *Acmaeodera* sp. were collected in the flowers; *Cardochilis* n. sp., *Cryptocephalus* sp., on the foliage; Gen. Nov. aff. *Stenophasmus* sp. on an infested boll, and *Lygaeus belfragei* Stal on boll.

The hymenoptera were det. by Gahan and Rohwer; coccid by Morrison; heteroptera by Gibson; ant by Mann.

C. H. T. Townsend."

Upon arrival in Washington the 22 pupae of the bollworm mentioned

[2]This species has been described as *Apanteles thurberiae* Muesebeck, in Proc. U. S. Nat. Mus. Vol. 58, pp. 507–508.

in Townsend's report were divided into two lots of 11 each. One lot was sent to T. C. Barber at Brownsville, Texas, and the other to J. D. Mitchell at Victoria, Texas.

Mr. Mitchell's rearing records are as follows:

Oct. 29, 1918,—pupae received at Victoria, Texas.
Aug. 2 to 8, 1919,—3 moths emerged.
Aug. 27, 1919—1 moth emerged.

The following are Mr. Barber's records:

Aug. 6, 1919,—1 moth emerged.
Aug. 23, " 1 " "
Aug. 26, " 1 " "
Aug. 29, " 1 " "
Sept 1, " 1 " "
Aug. 28, 1920,—1 " "

It will be noted from Mr. Barber's records that one individual remained in the pupa stage for practically two years.

Specimens submitted to Dr. Harrison G. Dyar were determined by him as representing a new genus and species of the family Noctuidae, Acronyctinae. He described it as "*Thurberiphaga catalina*.[3]

NOTES ON THE BIOLOGY OF *DESMOCERUS PALLIATUS*

By GLENN W. HERRICK, *Ithaca, N. Y.*

ABSTRACT

The cloaked knotty-horn beetle (*Desmocerus palliatus*) lives on the common wild elder and attacks the Golden elder which is used for ornamental purposes. The eggs have been found attached to leaves of the elder but it is questionable if this is normal. The larvae bore into the stems of the elder, just above and below the surface of the soil. The larvae pupate in the spring in their burrows in the stems and the adults appear during the last of May or early June. The beetles feed sparingly on the leaves before ovipositing.

This beetle, commonly known as the cloaked knotty-horn, is a native species and evidently widely distributed in the United States and it occurs in Canada. It has been recorded from Ontario, Canada, and in the United States from Massachusetts, Connecticut, New York, Pennsylvania, and New Jersey southward to Virginia, North Carolina, and Louisiana and westward to Indiana and Kansas, at least. Its original food plant is apparently the native elder (*Sambucus canadensis*) on which the beetles are often found in considerable abundance. For example, Mr. Morris in one of his delightful accounts of a collecting excursion, says, "in the little glade, among the thickets of elder, I captured seven specimens of this beautiful beetle in about an hour—always on the underside of the foliage or crawling on the stems****.

[3]Insecutor Inscitiæ Menstruus. Vol. VII, p. 188.

That season I took over seventy between June 20 and July 25, nearly always on early elder growing in woodland glades and generally on the foliage." The writer has taken the beetles at Ithaca on both the golden elder and the common wild elder. I have also collected it on the wild elder at Deposit, N. Y.

The beetle has been present here at Ithaca for some years on the golden elder used in lawn plantings. The larvae have proved to be seriously injurious to this very useful and beautiful shrub, greatly marring its symmetry and beauty by reason of the dead and dying branches that occur here and there throughout the growth.

The larvae work at the bases of the stems partly above ground but mostly below the soil. Their burrows run nearly parallel with the long axis of the stem and are usually packed full of castings. From six to eight inches above the soil the stems are full of the exit holes of the beetles while the interior is often riddled with burrows of the larvae.

The larva is creamy-white and when full-grown and extended is fully an inch in length and some specimens exceed an inch. The head is brown and the mandibles black in color. The prothorax is wide and flattened and each of the first seven abdominal segments bears a flattened area on the dorsal side reminding one of the much more prominent callosities on the dorsal sides of the segment of the larva of *Mallodon melanopus*. The pupa is slightly more than three-fourths of an inch in length and its appearance is well shown in plate 7.

The adults begin to appear here at Ithaca in June. My notes record one adult on June 14 and another on June 18. On June 13 I found three adults that had transformed in the larval burrows in the stems below ground but had not yet emerged. In the cages to which larvae were transferred on March 30, adults emerged (4 of them) as early as May 30 (1910). It is probable that the transformations of these specimens were accelerated somewhat by the unnatural conditions in which the larvae found themselves and perhaps the temperature was somewhat higher in the cages than in the portions of the elder below ground.

The beetles feed to some extent on the foliage of the elder, eating inward from the edges and producing notches in the leaves. One female was present on the plant and her activities followed for a little more than a week. The male was present on the 23rd of June and the two were in copulation at this time.

On June 14 I found what I supposed were the eggs deposited by another female present on the foliage. I had expected to find the eggs white in color and supposed they would be deposited on the bark near the bases

of the stems. The bodies which I took to be the eggs were deposited on the leaves on their sides and were fusiform in shape, of a clay-yellow color and the surface of each one was longitudinally wrinkled. They are well shown in plate 7. On June 16, 1921 I took several of the beetles on the common wild elder at Deposit, N. Y. These beetles were confined in tumblers with leaves of the elder for a day or two until time could be found to care for them. During the night of the 18th the beetles deposited several of the fusiform, clay-yellow wrinkled eggs in the tumblers identical in shape, size and appearance with those found on the leaves to which reference has already been made. On the 19th four more eggs were laid by one of the beetles. I did not, however, succeed in getting any of them to hatch. The eggs are about 3 mm. long and 1 mm. in diameter.

It is quite possible that the larvae may be destroyed by the use of paradichlorobenzene, applying it in the same manner as it is applied to control the peach-tree borer. I am inclined to think, however, that the gas might be more effective if the crystals were applied in the spring during the latter half of April rather than in the fall.

RED BUG CONTROL IN SOUTHERN PENNSYLVANIA

By J. R. STEAR, *Assistant Entomologist, Penna. Bureau Plant Industry, Harrisburg, Pa.*

ABSTRACT

The hatching period of the bright red bug, *Lygidea mendax*, in southern Pennsylvania comes so late in the blossom pink stage of nearly all varieties of apples that the pink spray is ineffective in control. A comparison of pink with the petal fall spray on the York Imperial, a late blooming variety, gave little difference in control. Two applications of nicotine gave no additional control. On earlier blooming varieties the petal fall spray would prove much more effective. One application of nicotine at petal fall is advised.

The species of red bug considered in this article is known as the false or bright red bug.[1] In southern Pennsylvania it is the species responsible, so far as observed for all injury to apples. The dark red bug,[2] thus far has not been collected or reared from apples at the Chambersburg laboratory.

The usual recommendation for red bug control, calling for a nicotine spray before the blossoms open has been followed in southern Pennsylvania with varying results. Considering this, it appeared desirable to correlate the hatching of the red bug nymphs with the blossoming of several varieties of apples.

In 1921 and 1922, the writer correlated the first hatching of red bugs with the blooming period of several apple varieties, viz., York Imperial,

[1] *Lygidea mendax* Reut. [2] *Heterocordylus malinus* Reut.

Desmocerus pallialus; Adult, Eggs, Pupa, and Larva in burrow.

Grimes Golden, Stayman Winesap and Jonathan. In 1921 the first nymphs were observed on April 7th, as many as six nymphs being found on a single blossom bud cluster. On this date all four varieties were in condition for spraying in the pink. By April 9th, however, all were partly in bloom except the York Imperial which did not bloom until April 14th. In 1922 the first nymphs were observed on April 23rd. At this time all varieties were in the pink stage, but by April 26th all were in bloom except the York Imperial which did not bloom until May 1st.

From this it appeared that except in the case of the late blossoming York Imperial, hatching occurred so late in the pink stage that the pink spray could not be delayed long enough to catch the nymphs. Even if it were possible to delay the pink spray until a couple of days before the blossoming period, not more than 50 to 75% of the nymphs would be exposed to the spray. In 1923 hatching occurred over a period of 6 days. Twenty-five percent of the nymphs hatched in the last four days of this period, during which time the trees were in bloom.

Frost[3] has shown that the hatching period of *L. mendax* occurs too late for the pink spray to catch many of the nymphs, and recommended that in red bug control nicotine be applied at petal fall and two weeks later rather than in the pink spray.

In order to compare the effectiveness of later sprays with the pink spray, and also to determine whether sufficient additional control is secured to justify two applications of nicotine, experimental spraying was carried on in an infested York Imperial orchard in 1922.

The orchard was divided into four plots which were treated as follows: Plot I sprayed in the pink. Plot II sprayed in the pink and at petal fall. Plot III sprayed at petal fall. Plot IV sprayed at petal fall and 2½ weeks later. Check trees were left in Plot I. The trees were twelve years old and 3–3½ gallons of spray were used per tree. Nicotine sulfate was used at the rate of ¾ pint to 100 gallons of dilute lime-sulfur. The pink spray was applied on April 26th, three days after nymphs were first observed. Petal fall spray was applied on May 8th, and the third spray on May 26th.

[3]Jour. of Ec. Ent., Feb., 1922

COMPARATIVE RESULTS OF RED BUG SPRAYS

Plot	Treatment	Tree No.	Total Apples	Red Bug Apples	Per cent Red Bug
I	Pink Spray	1	491	14	2.8
		2	1504	33	2.1
		3	576	4	.69
II	Pink and Petal Fall	1	795	8	1.
		2	354	9	2.5
		3	373	6	1.6
III	Petal Fall Spray	1	126	0	.0
		2	1213	26	2.2
		3	480	4	.83
IV	Petal Fall & Two & half wks. spray	1	138	1	.7
		2	275	4	1.45
	Checks	1	49	7	14.3
		2	838	110	13.1

In averaging up these results we get the following percentages: Pink spray 1.9% Red bug. Pink and petal fall 1.5%. Petal fall 1.64%. Petal fall and 2½ weeks later 1.2%. These percentages are so small and so close together that there is no practical difference in favor of any of the spray treatments. On the basis of these results and assuming careful spraying, we would conclude that a single application of nicotine at petal fall will give excellent control without an additional spray.

It is unfortunate that the experiment could not have included an earlier blooming and susceptible variety such as Grimes Golden. With such a variety the difference in favor of the petal fall over the pink spray should be very marked.

HABROBRACON JUGLANDIS ASHMEAD AS A PARASITE OF *PLODIA INTERPUNCTELLA* HUBN.

By E. R. DEONG, *University of California*

The Indian Meal Moth, *Plodia interpunctella* Hubn., in California is commonly attacked by the parasite *Habrobracon juglandis* Ashmead. Parker mentions it under the name of *Habrobracon hebetor* Say as frequently attacking this larva "but not appreciably affecting the infestation in California," (U. S. Dept. Bul. 235, 1915). This parasite was found to be the most abundant and widely distributed of any attacking *Plodia*, in a study of insects of stored products made in 1918 for the State Food Administrator. It was also found to breed upon a caterpillar recently introduced upon peanuts, *Aphomia gularis* Zeller.

The life history data were from insects in close confinement and

without the best equipment for such type of work. The temperature range was from 24° to 30° C. (75° to 86° F.) to simulate natural conditions in the ordinary warehouse of interior California during the summer.

LIFE HISTORY DATA OF *Habrobracon juglandis*

No.	Number of Specimens	Length of egg stage	Length of larval stage	Length of pupal stage	Period from egg to adult
		Days	Days	Days	Days
1	7	2	6	6 to 8	14 to 16
2	2	—	—	7 to 8	—
3	7	2	5 to 7	6 to 7	15 to 16
4	5	3 to 4	4 to 5	10 to 11	18 to 20
5	5	3	4 to 5	—	—
6	8	2	5	—	—
7	6	2 to 3	4	10	16 to 17
8	4	3	5	—	—
9	1	3	4	5	12
10	6	2 to 3	7	—	—
11	3	2	5 to 8	—	—
Average		2.6	5.2	7.4	16

The average development period of *Plodia interpunctella* under California conditions is given by Parker (former citation) at fifty-three days. Comparing this with the average period of sixteen days from egg to adult of the parasite, it will be seen that there is a possibility of three and a partial fourth generation to one of the host.

Oviposition Habits. The caterpillars frequently recognize the parasite as a possible enemy and may attempt to escape from it. After being stung, however, paralysis occurs in twenty to twenty-five minutes and then from one to three pearly white eggs are attached to the caterpillar. Three parasites were occasionally reared from one mature caterpillar, but in one instance when five eggs were deposited on a single host four larvae matured but only one adult emerged. Many caterpillars that were confined with parasites were stung and paralyzed even though no eggs were deposited upon them. In one instance eleven *Plodia* larvae and one female parasite were confined in a vial and within two hours all the caterpillars had been paralyzed. Some of these were kept for three weeks and at the end of this time they had shriveled up and turned black, but the exact time of death could not be determined.

Oviposition began in one or two days after the adults emerged and continued over a period of from seven to nine days. The total number of eggs recorded from a single parasite ranged from fifteen to twenty-four.

Scientific Notes

Note on the Cotton Boll Weevil in Kansas. On Oct. 10th and 11th I found quite a number of adults and larvae in bolls on cotton in southern Kansas, Montgomery County. This county lies immediately north of Oklahoma, and according to the best information I can get there is considerable cotton growing immediately south of this county.

Specimens of this insect have been submitted to Mr. J. L. Webb of the Bureau of Entomology, who states that they are typical cotton boll weevil.

E. G. KELLY,
Extension Entomologist.

A Mealy Bug on Grape. Grape growers in the vicinity of Lawton and Paw Paw, Michigan, during the summer of 1923, complained of injury to their grapes, caused by a mealy bug. The infected clusters were not only rendered unsightly by the presence of honey dew but the grapes showed a tendency to drop before they were ripe. This left the cluster ragged in appearance and exposed the white cottony egg masses along the stems. The mealy bug proved to be the omniverous species ***Pseudococcus maritimus*** Ehr., which is known to occur on a number of different hosts.

EUGENIA MCDANIEL,
Research Assistant in Entomology

The Effect of Low Temperatures on the San Jose Scale in Georgia. In taking records on the results of lubricating oil emulsions and other sprays for the control of the San Jose scale, *Aspidiotus perniciosus* Comstock, on peach trees in Georgia, notes were also made on the mortality of the insect from low temperatures. The table below gives in terms of percentages the dead scale insects found on the check or untreated trees of the experiment before and after the cold period.

Date (1923)	Treatment for scale	Minimum temperature	Percent scale dead
Feb. 9	No treatment	36° F	12%
" 16	" "	26° F	27%
" 19	" "	21° F	38%

The above table shows that as a result of the low temperatures there was an increased scale mortality of 26 % on the trees that had received no treatment whatever during the winter for the control of the insect. The minimum temperatures recorded for a four day period were as follows: Feb. 16, 26° F; Feb. 17, 23° F; Feb. 18, 18° F; and Feb. 19, 21° F. These temperatures were unusually low for Central Georgia, and some large female scales and *all crawlers* were killed during the period.

On March 20th, 1923, a minimum temperature of 23° F was recorded in Central Georgia which killed about 20% of the peach blooms, but did not affect the scale mortality to any extent. The minimum on the day before this freeze was 51° F and on the day after 35° F. The low temperature during the second cold period of 1923 in Georgia was perhaps of a too short duration to kill the San Jose scale.

OLIVER I. SNAPP and C. H. ALDEN, *U. S. Bureau of Entomology,*
Fort Valley, Georgia

Unusual Damage to the Floors of a House by a Species of Pemphredinid Wasp, Stigmus fulvicornis Rohwer. During the latter part of August 1923 the writer was requested to visit the home of Mr. Ed. Williams in Starkville, Miss. and investigate the damage to his floors caused by what he thought to be ants. After reaching Mr. Williams' home the writer was very much surprised to find a portion of the floor of his porch bearing numerous holes about the diameter of the head of an ordinary pin or slightly smaller. By the side of a number of these holes were small piles of sawdust. Flying in the air above these holes and crawling on the floor here and there were numerous small wasps which on superficial examination might have been taken to be parasites of whatever insect was damaging the floors. The holes in the floor bore a striking resemblance to those of Ipid beetles, in fact the writer would, upon a hasty examination, have concluded that a species of Ipid was the depredator and that the wasps were parasites on them. A very careful examination of several nests proved that the wasps were the cause of the damage and that they were using the floor as a place in which to construct their nests. A number of the insects were secured but they were so immature that no effort was made to have them determined.

With the literature available the writer was able to place the wasp in the genus *Stigmus*. Specimens were forwarded to Mr. S. A. Rohwer, of The United States National Museum, with a request for a specific determination. Mr. Rohwer wrote that the species was nearest *S. conestogorum* Rohwer, but differed from this species in a number of ways, enough to warrant him in calling it a new species, to which he gave the name *fulvicornis* because of its yellowish or ferruginous colored antennae. Mr. Rohwer took issue with the writer in regard to the wasp's ability to construct nests in the floor. He was of the opinion that the wasps were using the holes made by Ipid beetles or else nail holes for their nests. There is no doubt about the wasps constructing holes in the floor as Mr. Williams observed them carrying sawdust-like frass out of their holes. The writer also examined enough of the nests to be convinced that the wasps were solely responsible for the nests and not the wood-boring beetles, as one would ordinarily think.

A review of the literature dealing with the habits of the wasps of the genus *Stigmus* contains no reference to any species of the genus ever having attacked furniture or floors; normally the wasps breed in the stems of plants or twigs of trees but there is a reference to one species having been bred from a gall. It is left for one to speculate as to why this species should attack floors when there were plenty of trees and plants nearby in which it might have constructed its nests. Will this species continue to be a household pest or was this simply a variation in the habit of the wasp?

On September 10th, a further visit was made to the home of Mr. Williams where the writer's attention was called to the holes made in the floor of the dining room and hall. The floor was hard and well preserved, and not soft and punky like that of the piazza. Both floors were of pine but that of the piazza had been subject to weathering, while that of the interior of the house was almost as well preserved as it was when the house was built. After seeing the nests in this type of wood one was more than ever convinced of the wasp's ability to construct nests in other kinds of wood besides soft and decaying lumber. As a rule the nests in the interior of the house were constructed in the soft wood between the hard grain layers but this was not invariable, for a number of nests were observed which penetrated even the hard grain layers. On the porch a count of the nests occuring in one plank was made and it was found that fifty nests occupied this plank, which was about three

inches wide and four and a half feet long. The distribution of the holes in the plank was not uniform but the holes were rather scattered; in some places there were as many as six holes to the square inch, whereas in other places there were only one or two, or perhaps none, in an area equally as large.

One hole, which was examined, extended into the floor vertically for a distance of one-fourth inch when it suddenly turned at right angles and ran parallel with the surface of the floor for seven inches. In this gallery was found a great deal of frass, but no signs of the wasp or its immature stages.

The writer recommended that Mr. Williams treat each of the holes with carbon bisulphide by injecting this material into the holes with a little oil-can or syringe. This treatment to be followed in a couple of days by painting or varnishing the floor.

M. R. SMITH,
State Plant Board, A. & M. College, Miss.

The Aldrich Collection of Diptera. The National Museum has recently received as a gift from Dr. J. M. Aldrich his private collection of Diptera. This collection was begun in 1890, and for 28 years received a good share of the owner's efforts; since he went to the National Museum in 1918 it has, however, received no additions. A recent inventory showed it to contain 44,610 pinned specimens and 4,145 species fully named; 534 of the latter were represented by type material. There are some hundreds of undescribed species; and as Dr. Aldrich collected for many years in the Pacific Coast and Rocky Mountain regions, his collection contains many named species not heretofore represented in the National collection.

Dr. Aldrich also donated to the museum his card index of the literature of North American Diptera, begun in 1898 and now extending to about 70,000 references as nearly as can be estimated. With the exception of about 20 hours' work, this is all by the hand of the owner himself, and represents to a large extent his own conclusions from the literature rather than a mere compilation.

In a letter to his chief presenting the collection and index, Dr. Aldrich states that he was deterred from taking this action sooner because the salaries paid by the museum are still on the scale established in 1882 (except for a temporary war bonus of $240), and he did not feel sure that he could continue permanently as one of the curators. Recently, however, under the reclassification act passed by the last congress, the museum staff have been assured of a new pay schedule approximating the requirements of the present time. SCIENCE, *October 19, 1923*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1923

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication, at $3.00 per page for all matter in excess of six printed pages; in the case of other matter, the maximum of 2,500 words is still operative. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded or the proof returned, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

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The association is growing. The increase in membership, the demand for larger publication facilities, the desire for more branches and sections are all healthy signs. There are a number of amendments to the constitution to be acted upon at the coming meeting. Marked changes in the classification of the members are proposed. This matter should be given careful consideration by all interested in the welfare of the organization.

The arrangement of the program is one of the perplexing problems. Some are certain to be inconvenienced whatever plan is followed. There are so many papers and such a multiplicity of overlapping interests, that compromises are inevitable. It is easy to make suggestions. They may work at one meeting and not at another, because the programs may and usually do differ greatly. The large meeting presents problems quite different from those of the smaller gatherings. An increase in the number of branches would assist materially in reducing the congestion of the program at the annual meetings and would permit men to attend entomological sessions who now find it practically impossible to get to meetings. This last means much to the younger men.

It is gratifying to state that abstracts appearing with the published papers appear to be approved "in principle," especially if the editor prepares them. Occasionally a paper is submitted for publication with the abstract. More often a request is necessary and occasionally authors have misinterpreted our letter and assumed that it was proposed to substitute the abstract for the paper. These summaries are valuable to every reader in indicating the nature of the paper. It is presumable that the author knows better than anyone else the contents of his paper. The day is not distant when a paper without an abstract prepared by the author will be regarded as incomplete.

Current Notes

Dr. T. L. Guyton of the Pennsylvania Bureau of Plant Industry received the Ph.D. degree at Ohio State University at its recent Commencement.

Mr. Loren B. Smith has been placed in charge of the Japanese beetle project of the Bureau of Entomology at Riverton, N. J.

Mr. Don B. Whelan has been appointed instructor in entomology at the University of Nebraska and assistant in entomology in the Station.

According to the *Experiment Station Record*, Mr. E. L. Ayers, entomologist and pathologist of the Extension Service of Florida University has been transferred to the Florida Station as agriculturist.

Mr. R. W. Dawson, assistant professor of entomology at the University of Nebraska, and assistant in entomology in the Station, resigned July 1, to pursue graduate studies at the University of Minnesota.

According to *Science*, the Plant Quarantine Station at Yokohama, Japan, was destroyed by the earthquake, but Dr. S. I. Kuwana was absent in Korea.

Dr. L. I. Huber and Mr. C. R. Neiswander have recently been appointed assistants in entomology at the Ohio Agricultural Experiment Station, Wooster, Ohio.

Prof. H. A. Gossard, during October, spent a few days at the Summit Nurseries, Monticello, Fla., where he is interested in a large pecan plantation.

Mr. Herbert J. Pack of the Agricultural Experiment Station, Logan, Utah, is now connected with the department of entomology of Cornell University, Ithaca, N. Y.

Mr. F. C. Craighead who has recently been appointed forest entomologist in charge of Forest Insect Investigations for the Bureau of Entomology, reported for duty September 14.

Dr. Wm. P. Hayes resumed his work at the Kansas State Agricultural College September 1st, after a year's leave of absence spent in study at Cornell University.

Mr. W. J. Gerhardt of the Field Museum, Chicago, spent two days in Washington studying museum equipment, and visited the Division of Insects to consult with various entomologists.

Mr. D. C. Mote, formerly a member of the staff of the Ohio Station, and more recently State Entomologist of Arizona, is now associate entomologist of the Oregon Station.

Dr. W. D. Hunter and Messrs. B. A. Coad and G. A. Maloney of the Bureau of Entomology attended the national boll weevil menace convention at New Orleans, October 25 and 26.

Dr. W. M. Mann of the U. S. National Museum left September 17 for Mexico, to continue his investigations of fruit flies in connection with work for the Federal Horticultural Board.

At Cornell University a new insectary has been completed. It will be used chiefly for research, but will provide facilities for a course on photography and methods of rearing insects.

Prof. B. B. Fulton of the Oregon Agricultural Experiment Station who was recently married, toured the eastern United States and visited the Entomological Department, Ohio State University, his Alma Mater, in August.

Prof. S. W. Bilsing of the Texas A. & M. College has been granted a year's leave of absence and will spend it in graduate study in entomology at Ohio State University.

Mr. J. C. Bridwell, formerly of the Pacific Coast and Hawaii, is now in Brooklyn, N. Y., and visited the Entomological Department of the Agricultural Experiment Station, New Haven, Conn., on October 29.

Dr. M. W. Blackman, teacher of forest entomology in Syracuse, N. Y., spent two days in the Section of Insects, U. S. National Museum, conferring with various workers and studying types of certain scolytid beetles.

Dr. L. O. Howard, Chief of the Bureau of Entomology, has been appointed president of the International Conservation Conference to be held at Honolulu in 1924 under the auspices of the Pan-Pacific Union.

Prof. R. C. Osburn, head of Department of Zoology and Entomology, Ohio State University, spent several weeks during the summer at the Lake Laboratory at Put-in-Bay engaged in research work on the Lake fauna.

Appointments in the Bureau of Entomology have been announced as follows:—H. S. Adair, Mississippi Agricultural College, junior entomologist, pecan insect investigations, Thomasville, Ga.; Luther Brown, Mississippi Agricultural College, plant quarantine inspector, Riverton, N. J.

Mr. D. C. Parman of the Uvalde, Tex., laboratory of the Bureau of Entomology recently made a trip through the Gulf States, investigating various species of insects injurious to domestic animals in that region.

Dr. F. H. Lathrop who received the Ph.D. degree at Ohio State University in June has been placed in charge of a substation of the New York Experiment Station at Highland, N. Y., under the direction of Prof. Parrott.

According to *Science*, Prof. J. W. McColloch of the Kansas State College has been named acting head of the department of entomology, during the absence of Prof. G. A. Dean, who has a year's leave of absence.

Dr. T. J. Potgieter of South Africa took his Ph.D. degree at Ohio State University in June and has started on his return trip by way of England to South Africa where he will engage in entomological work.

Prof. George M. List, chief deputy entomologist, Colorado Agricultural College, spent most of the afternoon of October 4 in the Section of Insects, U. S. National Museum, studying the methods of filing cards and the arrangement of the collections.

Mr. Josef N. Knull for several years connected with the Pennsylvania Bureau of Plant Industry, has been appointed as research assistant to Prof. Herbert Osborn and will combine work in this connection with graduate studies at Ohio State University.

Mr. F. E. Todd of the entomological staff of Arizona Board of Agriculture with his wife visited the Entomological Department, Ohio State University in August. He is inspecting the entomological work at the various state stations and expects to return to Arizona in a few weeks.

The temporary appointment of Mr. Henry L. Viereck has been extended six months from October 1 by the Division of Systematic Entomology, Entomological Branch, Department of Agriculture, Ottawa, Canada. Mr. Viereck will devote his time to the arrangement of the Hymenoptera in the National collection.

Mr. T. J. Naude, graduate student from South Africa at Ohio State University, visited the Experiment Stations at Wooster, Ohio, Geneva, N. Y. and the Entomological Department and Experiment Station at Cornell University during August to inspect the organization and methods employed in entomological work at these stations.

Dr. Albert Hartzell has been appointed to a National Research Council Fellowship under the Crop Protection Institute and will spend the year at Geneva with Prof. P. J. Parrott in investigations with sulphur as an insecticide. He received the Ph.D. degree at Ohio State University in June.

Prof. and Mrs. T. D. A. Cockerell of the University of Colorado, who returned from Siberia in September were on board the steamship Empress of Australia in Yokohama harbor when the earthquake occurred, but they were uninjured. This steamship being disabled, they were transferred to the President Jefferson.

Mr. Morgan Hebard of Philadelphia spent October 19 in the Section of Insects, U. S. National Museum, studying specimens in the collection and arranging for exchanges of various Orthoptera. Mr. Hebard brought with him many specimens of Orthoptera which he had borrowed from the collection for study.

Mr. N. I. Iskander, assistant entomologist of the Egyptian Department of Agriculture, visited the Section of Insects, U. S. National Museum, October 9. Mr. Iskander was especially interested in the collection of Coccidae and in the arrangement of the collections, especially in the tray system, and also in the organization of the work in the Section of Insects.

Dr. W. L. Chandler, formerly a member of the entomological department of the Michigan Agricultural College and Station, and who is a specialist in parasitology, has been transferred to the department of bacteriology in the newly created section of veterinary science and bacteriology of the same institution, where he will continue work on the parasites of food animals.

At the Utah College and Station, Dr. I. M. Hawley, head of the department of zoology and entomology has been appointed acting dean of arts and sciences, and H. J. Pack assistant professor of zoology and entomology in the College and assistant entomologist of the Station has been granted a year's leave of absence for graduate study at Cornell University.

Dr. Waldemar Pospelov, director of the bureau of entomology of the Agricultural Scientific Committee of Russia arrived in the United States in September and has since visited the Bureau of Entomology at Washington, the entomological departments of the Ohio State University at Columbus, Ohio, University of Illinois, Urbana, Illinois, Cornell, Harvard, and the Connecticut Agricultural Experiment Station, New Haven.

Entomological News records the death of the following European entomologists:—William Evans, Edinburgh, Scotland, October 23, 1922; the Reverend Canon William Weeks Fowler, Coleopterist, at Earley, Reading, England, June 3, 1923; A. L. Montandon, Hemipterist, at Jassy, Rumania; M. Paul Mabille, Lepidopterist, at Perreux, France, April 26, 1923; Eugene Boullett, Lepidopterist, and Ed. Blanc, Coleopterist, both of France, dates not given.

Dr. Carlos de la Torre y Huerta, of Cuba, recently visited the National Museum in Washington, D. C., and while there paid a visit to the Division of Insects to renew

his acquaintance with the various members of the section, especially Doctor Mann. Dr. de la Torre has charge of the Natural History Collections in Havana, and supervision over the well-known Gundlach collection.

Mr. M. M. High, of the Bureau of Entomology, who for a number of years has been engaged in the study of truck-crop insects in southern Texas, including the sweet-potato weevil, is planning to transfer his laboratory from Kingsville, Tex., to Poplarville, Miss., where he will be engaged on a study of the new Australian tomato weevil, in addition to completing his biological work on the sweet-potato weevil.

Entomologists from the principal pea-canning States will meet in Washington November 20 and 21 for a conference on the pea aphis. Stock will be taken of the year's developments and plans made for future work. On November 21, several of the entomologists connected with insecticide companies which have been carrying on active work against the pea aphis will join the conference and discuss the development of insecticides for the control of this insect.

Prof. Herbert T. Osborn, who is employed by the Hawaiian Sugar Planters Experiment Station, and who has been collecting parasites in various parts of Mexico for the Hawaiian Board of Agriculture, has had an extension of his assignment to this work and will continue work in Mexico. According to reports from Honolulu, some of the importations he has forwarded have proven very successful, especially parasites of the pineapple mealy bug, which was causing serious losses in the pineapple crop.

On October 4–6, Mr. L. S. McLaine of the Entomological Branch, Ottawa, Can., was present at a gipsy moth conference held in Albany and visited a new outbreak which has recently been discovered in Alburgh, Vermont. The infestation is on the peninsula at the north end of Lake Champlain and is only half a mile from the Quebec border. It is regarded as very serious and additional scouting will be carried on in Quebec immediately north of the infestation.

The Diamond Jubilee Meeting of the Entomological Society of Ontario was held at Ottawa, Canada, November 1st, 2nd and 3rd. There was a good attendance and a most interesting program. The Gipsy Moth and the European Corn Borer were given special places on the program. The address of President Morris, given in connection with a very pleasant dinner, was an inspiration to all students of nature. The United States were represented at the meeting by A. F. Burgess, who delivered the popular address, and by M. D. Leonard, H. L. McIntyre and E. P. Felt of New York State.

Mr. C. F. W. Muesebeck of the Gipsy Moth Laboratory, Melrose Highlands, Mass., has spent about four weeks in the Section of Insects, U. S. National Museum, identifying parasites and studying the Braconid genus Microbracon. Mr. Muesebeck has devoted considerable time to this difficult genus and hopes to be able to complete the revision of the North American species the coming season. Before returning to his headquarters at Melrose Highlands, Mass., he visited the collections in Philadelphia and also those in New Haven, to examine types.

A conference on the European corn borer was held at the laboratory of the Bureau of Entomology, 10 Court Street, Arlington, Mass., on September 28, followed by a trip to infested fields in the vicinity. The following entomologists and administrative officers were present: Arthur Gibson, L. S. McLaine and R. C. Treherne, Dominion of Canada; Commissioner of Agriculture Truax and R. Faxon, Columbus, Ohio;

C. H. Hadley, Harrisburg, Pa.; M. P. Zappe, New Haven, Conn.; G. A. Dean, Washington, D. C.; L. H. Worthley, D. J. Caffrey and D. W. Jones, Arlington, Mass.

A conference called by State Director of Agriculture Truax at Wooster, Ohio, in July, was attended by Prof. H. A. Gossard, J. S. Houser, L. L. Huber, C. R. Neiswander and C. R. Cutright of the Station staff, Mr. Fall representing the Federal Department, Mr. Faxon for the State Bureau of Plant Industry, and Herbert Osborn for the Extension Department of the State University as entomologists; officers of the Board of Agriculture and Experiment Station were also present. A number of matters of policy relating to control measures for the corn borer were discussed and definite agreement reached on a number of points.

A conference of entomologists and others interested in chinch bug control in the southwestern winter wheat territory was held in the office of the Southwestern Wheat Improvement Association at Kansas City, Mo., October 29. The following entomologists were present: T. B. Gordon, Oklahoma State Board of Agriculture; C. E. Sanborn, Oklahoma Experiment Station; M. H. Swenk, University of Nebraska; Otis Wade, Extension Entomologist of Missouri; E. G. Kelly, Extension Entomologist of Kansas; J. W. McColloch, Kansas State Agricultural College and S. J. Hunter, Kansas University. Plans were prepared and endorsed by all present for an unified campaign of winter burning to control the chinch bug in Oklahoma, Kansas, Missouri and Nebraska.

An initial meeting of the entomologists of Indiana was held at Purdue University, Lafayette, Indiana, October 26. The purpose of this conference was to enable the men throughout the State interested in entomology to become better acquainted with one another and with the problems with which each is dealing that they might better cooperate and be of mutual assistance, and also, so far as possible, to promote the entomological interests within the State. Those participating in the conference included the following: W. S. Blatchley, E. B. Williamson, A. C. Kinsey, F. N. Wallace, H. F. Dietz, B. E. Montgomery, W. H. Larrimer, W. B. Noble, H. R. Painter, B. A. Porter, J. Troop, W. A. Price, C. R. Cleveland, G. M. Stirrett, H. E. Enders and J. J. Davis. J. G. Sanders was a visitor.

According to *Science*, the 91st meeting of the Pacific Coast Entomological Society was held at the University of Southern California, Los Angeles, September 11. Dr. J. A. Comstock was elected chairman and H. E. Burke secretary. The following members and guests were present: A. J. Basinger, H. E. Burke, R. E. Campbell, J. A. Comstock, F. R. Cole, H. S. Fawcett, C. K. Fisher, R. D. Hartman, Trevor Kincaid, A. O. Larson, Isabel McCracken, H. S. Smith, H. E. Summers, E. P. Van Duzee, Mr. and Mrs. W. H. Volck, Mr. and Mrs. W. S. Wright, Mr. Osterhout. The following papers were presented: "Problems of the Amateur Entomologist" by W. S. Wright; "Entomology at the California Academy of Sciences" by E. P. Van Duzee; "Curious Diptera from the Philippines and Adjacent Regions" by F. R. Cole; "The Alder Sawfly," "The European Earwig" by Trevor Kincaid; "The Rediscovery of a Lost Species" by J. A. Comstock.

According to *Science*, a permanent organization to be known as the National Bollweevil Control Association was created on October 26, marking the end of the bollweevil menace conference at New Orleans. The association will be perfected by an executive committee of twenty-two members, representing the varied interests

of the cotton industry. Claude G. Rives, Jr., of New Orleans, president of the Louisiana Bankers' Association, chairman of the conference, named part of this committee, which will meet on November 17 in New Orleans, when the full personnel will have been named. Those already named on the committee include: from the Department of Agriculture, W. D. Hunter and B. R. Coad, who is in charge of the Federal bollweevil experimental station at Tallulah, La.; from the Association of Southern Agricultural Workers, W. E. Hinds, of the Alabama Polytechnic Institute, and D. C. Hull.

The following resignations from the Bureau of Entomology have been announced: L. M. Bertolf, assistant bacteriologist, bee culture investigations, to become instructor of biology, North Carolina College for Women, Greensboro, N. C.; L. L. Benton, W. C. Gideon, J. G. Lewis, G. E. Hawkins, K. M. Mace, C. A. Bolt, W. H. Craven, J. H. Hunter, C. Ling, L. C. McCraw, A. L. McCrary, W. D. McGowan, F. G. Martin, M. C. Martin, R. L. Martin, D. L. Outen, S. D. Reid, T. D. Rictenbaker, T. S. Smith, J. N. Todd, A. M. Bacot, E. B. Barnett, G. R. Fulton, L. F. Greer, S. B. Hendricks, L. P. Hodges, B. C. House, D. E. Lott, T. E. McNeel, A. L. Monroe, R. W. Necaise, S. Sevier, of the bollweevil force; L. L. English, Mexican bean beetle, to become a graduate assistant at the Iowa Agricultural College, where he will investigate insecticides and work for the doctorate; Dr. Arnold P. Sturtevant, bee disease work, to accept a position in the bacteriological department of the New York Homeopathic Medical College; W. D. Mecum, field assistant, Madison, Wis.; C. H. Hadley, Riverton, N. J., to become Director, Bureau of Plant Industry, Harrisburg, Pa.

Notes On Apiculture

The fall meeting of the Connecticut Beekeepers' Association was held at the State Capitol, Hartford, October 20.

The annual meeting of the Indiana State Beekeepers' Association will be held at Indianapolis on Thursday and Friday, December 13 and 14. Mr. C. O. Yost, State House, Indianapolis, is the Secretary.

Mr. Wallace Park has resigned his research work in apiculture at the Iowa Agricultural Experiment Station to take charge of the beekeeping work in the department of entomology at the University of Illinois:

The annual convention of the New Jersey Beekeepers' Association will be held on January 17 and 18 at Trenton, in connection with Agricultural Week activities. Mr. Jay Smith of Vincennes, Ind., has been engaged as one of the speakers.

A beekeepers' conference was held Thursday, November 8, at the Eastern Apple Exposition and Fruit Show at the Grand Central Palace, New York City. Some of the speakers were Dr. E. F. Phillips, Prof. E. N. Cory, George H. Rea and E. R. Root.

Dr. Robert Burri, whose work on the brood diseases of bees is well known and who is now director of the Dairy Experimental Station at Liebefeld, Switzerland, was in Washington during the International Dairy Conference. He reports that the work on the control of the Isle of Wight disease in Switzerland is progressing favorably.

Mr. R. L. Parker of the Department of Entomology has been transferred to take charge of the research work in Apiculture of the Iowa Experiment Station, succeeding Wallace Park who has gone to the Department of Entomology at the University of Illinois. Mr. Parker is at present working on his Doctor's Degree in Apiculture, having already received his Master's Degree in Apiculture, so that he comes to the

work thoroughly trained to follow the researches which have been started in the Agricultural Experiment Station.

Dr. E. F. Phillips will attend a series of meetings in South Dakota, North Dakota, Montana, Wyoming, Colorado and Nebraska between November 20 and December 6, the schedule having been arranged through the American Honey Producers' League committee on meetings of which Mr. Russell H. Kelty is chairman.

In connection with the Eastern Apple Show and Fruit Exposition held at the Grand Central Palace, New York City, November 3rd to 8th, there were extensive exhibits of honey. Thursday, November 8th, was "Honey Day" and on that day meetings were held which were well attended by beekeepers of the adjoining states and at which the uses of honey and its marketing were discussed. The meetings were held under the direction of R. B. Willson, Extension Specialist for New York State.

A short course in beekeeping will be held at Purdue University, Lafayette, Indiana, February 11th to 14th.

The "bee louse," *Braula coeca*, a well-known visitant of the bee colony in almost all parts of the world, has been repeatedly imported into the United States on queen bees from foreign countries and as a rule has disappeared promptly after the introduction of the imported queens into full colonies. As a result American beekeepers have believed that this species could not become established in this country. Several years ago it was reported that this species occurs in Carroll County, Md., and another report has been received from an apiary in central Pennsylvania. E. L. Sechrist recently visited Carroll County and found this species in the apiaries of one firm of beekeepers, and it probably occurs to a limited extent elsewhere in the locality. No damage seems to occur in strong, healthy colonies of bees. It is especially noted that if a colony of black bees containing Braula is queenless for a time, when an Italian queen is introduced, she is immediately covered with large numbers of Braula, and the beekeepers claim that in such cases the young Italian queen soon comes to look like and behave like an old worn-out queen. Material was collected and brought to Washington in which many adults and also eggs and pupae were found. Developmental stages were found to occur in tunnels under the capping of sealed honey. Until recently Braula has been supposed to be similar in its mode of development to the sheep tick, which develops to the pupal stage inside the parent. Since Braula deposits eggs, it can not belong to the same series of Diptera as the sheep tick. With the material now at hand it should be possible to establish the relations of this interesting insect to other Diptera.

Horticultural Inspection Notes

Mr. Perry A. Glick, formerly Assistant Entomologist of Arizona, has been appointed as Plant Quarantine Inspector to assist in the enforcement of the Fruit and Vegetable Quarantine, No. 56, at the port of New York.

Mr. L. R. Warner, who is in charge of the activities of the Florida Plant Board at Key West, recently visited Washington for the purpose of conference with officials of the Federal Horticultural Board.

Dr. W. A. Orton visited Cuba in November for the purpose of studying the potato situation, and incidentally looking into the possibilities of fruit flies infesting fruits which may be offered for entry into the United States.

Mr. Robert L. Trigg, a graduate of the Mississippi A. & M. College, who during

the summer months was engaged at Gainesville, Florida, in work for the National Research Council, was appointed Plant Quarantine Inspector October 1, 1923 with assignment in New York.

Mr. H. W. Lamp, an inspector of the Federal Horticultural Board, located in El Paso, Texas, was in Washington during the month of October assisting in the inspection and certification of plants introduced under special permit.

Mr. Harry B. Shaw visited Washington during the month of October for the purpose of conference to determine methods to be employed in enforcing the Fruit and Vegetable Quarantine, No. 56, which became effective November 1, 1923. Mr. Shaw is in charge of the work of the Federal Horticultural Board in New York City.

Mr. O. D. Deputy, Chief Inspector of the Mexican Border Service, visited Laredo, Texas during the month of October for the purpose of perfecting the present method of distributing the gas from the generators throughout the car fumigation units.

Mr. F. A. Johnston, an inspector of the Federal Horticultural Board, stationed in Washington, D. C., visited St. Louis, Missouri in September for the purpose of examining a shipment of orchids from Colombia.

Contraband cotton lint and seed continue to arrive at various ports of entry. Messrs. Kisliuk and Cogswell intercepted, in September at Philadelphia, five pounds of raw cotton containing over one hundred seeds in a passenger's trunk, arriving from Italy. The cotton originated in Dalmatia. Cotton samples from India were in a number of instances found to contain cotton seed. Mr. Kisliuk also collected cotton seed in an egg-case containing oranges and orange leaves which arrived from Argentina.

The European Earwig has been intercepted on several occasions in boxes arriving in Washington containing material imported under special permit. These shipments were received from Holland and England.

Agriotes lineatus Linn., a wireworm which is reported to be common in Europe in fields and meadows, was collected about the roots of Amaryllis arriving from Germany, by Mr. R. G. Cogswell. Apparently this injurious wireworm is not established in the United States.

The Avocado Weevil, *Heilipus lauri* Boh., was intercepted on two occasions during the month of June by the inspectors of the Federal Horticultural Board, located in Eagle Pass, Texas; and the Mexican Fruit Fly was collected by Mr. T. A. Arnold in oranges arriving from the interior of Mexico at El Paso.

An egg mass of the Gipsy Moth was taken in apple stock arriving in the foreign mail at Philadelphia, by Mr. Chester A. Davis in October. Interceptions of this type illustrate the importance of close cooperation on the part of the Postal Officials and those engaged in the inspection of foreign plant material.

The week ending October 6 was a busy one for the inspectors of the Federal Horticultural Board located in Boston. During that period, 59 interceptions of contraband were made in passengers' baggage. In addition, 486 individual plants, 9 bundles of mixed plants, 3 bushels of sweet potatoes, ½ peck of corn on the cob, and a number of Irish potatoes were intercepted in the course of ship inspection.

Medical Entomology

The unusually early appearance of *Hypoderma lineatum* in the subdermal tissue in the backs of cattle in Texas is noteworthy. In certain sections of the plateau region the larvea were fully developed about the middle of August. In the vicinity of Dallas the appearance of larvae in the backs of cattle is about one month earlier than normal, considerable numbers being present during the latter part of September. Under favorable weather conditions it is almost certain that a rather large emergence of the adults of this insect will take place during the fall and early winter months.

Dengue fever has been reported from the southern states from Georgia westward. The first case reported for Georgia was in the week ending October 12 and no cases have been reported from Florida. It is noteworthy that although the disease appeared rather early during the summer it did not gain great headway. This might be explained partially by the large percentage of immunes following last years epidemic and partially by the relatively smaller numbers of the yellow fever mosquitoes. This mosquito has been noticeably less abundant in Dallas than it was last year though this may not be the case throughout the South.

The following is the number of cases of dengue given in the "Public Health Reports" up to and including the week ending October 26:

Georgia	8
Alabama	35
Arkansas	6
Louisiana	259
Texas	422

According to *Science*, the Widow of the late Surgeon General William C. Gorgas is collaborating with Burton J. Hendrick, author of "The Life and Letters of Walter H. Page," in preparing a biography of General Gorgas, which, it is hoped, may be published during the coming year.

According to *Science*, The London School of Tropical Medicine has arranged to send an expedition to Samoa to study the prevention of elephantiasis and filariasis, diseases which affect 85 per cent. of the inhabitants of the Samoan group. The expedition will have its headquarters at Apia and will be away for two years; it will work in cooperation with the New Zealand government, which is responsible for the administration of Samoa. The expedition, which will leave England on November 15, will be under the leadership of Dr. Patrick Buxton, who did valuable work on entomology in Mesopotamia during the war, and has recently been entomologist to the Palestine Government at Jerusalem.

ERRATA

The illustrations on plate 4 are printed upside down, consequently the directions in relation to figures 3 and 4 in the explanation of the plate are the reverse of correct.

INDEX

Aedes aegypti, 97
  calopus, 380
Aegeria exitiosa, 376
Alabama argillacea, 458
Alden, C. H., 552
Aldrich collection, 553
Alfalfa caterpillar, 379
American Association
  Economic Entomologists
    attendance, 2
  Biological societies delegate, report, 9
  circulation agent, 8
  constitution, amendments, 17
  Crop Protection Institute, report, 18
  Executive committee, report, 9
  Membership committee report, 27
  Nomenclature committee report, 21
  Nominations committee report, 29
  National research council, report of representative, 14
  Policy committee, report, 16
  Resolutions committee report, 26
  Secretary, report, 4
Amorbia humerosana, 459
Anabrus simplex, 379
Anasa tristis, 73
Anderson, O. G., 463
Anthonomus grandis thurberiae, 544
Aphis hederae, 490
Aphycus lounsburyi, 507, 509, 511, 513
Apiculture classes, 130
Apple and thorn skeletoniger, 207
Apple flea-weevil, 394
Apple red bug, 94
Apple worm, 270
Armitage, H. M., 511
Arnold, G. F., 161
Aspidiotus perniciosus, 395
Atta insularis, 326

Ball, E. D., 182
Basinger, A. J., 456, 522
Beattie, R. Kent, 146
Bee disease, 412
  language, 228
  wintering, 321
Bees, 2-year brood curve, 117
  vs. spraying, 527
  winter protection, 125
Beekeeping in Texas, 113
Beet leaf-hopper, 379, 476, 479
Biological control, 506, 531
Bishopp, F. C., 97, 103, 222
Boll weevil, 552
Bordeaux mixture, 314
Box leaf miner, 435
Bradley, W. G., 307
Brittain, W. H., 61
Britton, W. E., 207, 395, 458
Brown tail moth, 317
Brues, C. T., 46
Burgess, A. F., 145, 213, 249
Burroughs, A. M., 534

Cabbage maggot, 61, 68
Caffrey, D. J., 292
Calcium caseinate, 203
  cyanide, 327, 328, 553
Calendra, 341
Caliroa aethiops, 98
Campbell, R. E., 497
Camphor scale, 43
Canker worm, 241
Carbohydrates as bee food, 117
Carbon bisulphide, 388
Carpocapsa pomonella, 270
Carsner, Eubanks, 476
Cartwright, W. B., 432
Catalpa sphinx, 242
Catchings, T. F., 459
Cave cricket, 460
Ceratomia catalpae, 241
Ceuthophilus sp., 460
Chapman, R. V., 84, 197, 341
Chemistry for entomologists, 172
Chortophila brassicae, 61, 68
Citricola scale, 225
Clausen, C. P., 225
Cloaked knotty horn, 546
Cnidocampa flavescens, 292
Coccus pseudomagnoliarum, 225
Codling moth, 270
Colorado potato beetle, 326
Connor, M. E., 380
Conotrachelus nenuphar, 275
Cook, F. C., 222, 398
Cook, W. C., 327
Corn ear-worm, 379
Cory, E. N., 81, 130, 226
Corythucha cydoniae, 458
Cotinis nitida, 396
Cotton moth, 458
Craighead, E. M., 376
Crampton, G. C., 460
Culex quinquefasciatus, 97
Currant aphis, 93
Cutright, C. R., 448

Dean, G. A., 192, 288
De Long, D. M., 88, 194
Dengue fever, 97
DeOng, E. R., 486, 550

Desmocerus palliatus, 546
Diabrotica vittata, 363
Diprion simile, 386
Diptera, Aldrich collection, 553
Disonycha laevigata, 459
Doane, R. W., 527
Domestic quarantines, 253
Doucette, C. F., 283
Dudley, J. E., 363
Dusting tall trees, 241

Economic Entomology, Problems, 39
Eleodes hispilabis, 96
Empoa rosae, 315
Empoasca mali, 315
Emulsions, oil, 430, 534
Entomologist and Public,176
Entomologists, training, 168
Entomology, Folsom, 101
Erythroneura comes, 315, 353
  tricincta, 315
Essig, E. O., 459
Euceraphis deducta, 395
Euproctis chrysorrhoea, 317
European corn borer, 292, 317
  earwig, 369, 458
  pine sawfly, 386
  rose slug, 98
Eurymus eurytheme, 379
Eutettix tenella, 379, 476, 479
Euzenilliopsis diatraeae, 227

Federal Horticultural Board, 138
Felt, E. P., 39, 61, 226
Fenton, F. A., 314
Fernald, H. T., 194, 292
Fire ant, 96
Fiske, W. F., 417
Flat headed borer repellent, 97
Flint, W. P., 209, 328
Fly repellents, 222
Folsom, J. W., 101
Forficula auricularia, 369
Forest entomology, 51, 413
  tent caterpillar, 56
Foulbrood control, 115
Fracker, S. B., 133, 327
Frost, S. W., 304, 393, 394, 459, 461
Fullaway, D. T., 531
Fulton, B. B., 369
Fumigation, barracks, 323

Gipsy moth, 43, 53, 61, 158
Glasgow, Hugh, 68, 90
Glenn, P. A., 79
Gooderham, C. B., 133
Graham, S. A., 51
Grape leaf hopper, 353
Green June beetle, 396
Griffin, E. L., 430
Grube, W. M., 435

Habrobracon juglandis, 550
Hadley, C. H., 349
Hamlin, J. C., 420
Hartley, E. A., 386, 434
Haseman, Leonard, 141, 270
Hawley, I. M., 377
Headlee, T. J., 95, 158
Helix aspersa, 456
  pisana, 456, 522
Hemerophila pariana, 207
Herbert, F. B., 494
Herrick, G. W., 546
Hessian fly, 288, 293, 299, 432
Heterocordylus malinus, 548
Holloway, T. E., 326
Homalotylus africanus, 517
Hopkins, A. D., 413
Horseflies, 307
Horsefall, J. L., 553
House fly, 357
Hough, W. S., 198
Houser, G. S., 213, 241
Howard, L. O., 161
Hungerford, H. B., 99
Hydrocyanic acid gas, 84, 518
Hypoderma sp., 102
Hyslop, J. A., 215

Important foreign insects, 152
Insect food choice, 46
  pest survey, 215
  refrigerator, 539
Insecticides and Fungicides, 463
Inspecting nursery stock, 141
Isle-of-Wight disease, 133, 136

Japanese beetle, 312, 349
Jones, T. H., 307

Keen, Sadie E., 395
Kellogg, Vernon, 185
Kelly, E. G., 552
Kernel spot,440
King, G. E., 321
Kuhn, H. A., 323

Laake, E. W., 222
Larch sawfly, 53, 56
Laspeyresia molesta, 393, 461
Leach, B. R., 312
Leafhoppers, 314, 353
Lefroy, H. Maxwell, 463
Lepidosaphes ulmi, 392
Leptinotarsa decimlineata, 326
Liponyssus bacoti, 226
  bursa, 227
Longistigma caryae, 446
Loxostege sticticalis, 378
Lyctus sp., 226
Lygidea mendax, 548

MacLeod, G. F., 424
Macrosiphum pisi, 394
Manual of Entomology, 463
Marlatt, C. L., 138, 166, 193, 251
McClendon, S. E., 99
McColloch, G. W., 293
McCubbin, W. A., 253
McDaniel, Eugenia, 552
McLaine, L. S., 145
Mealybugs, 326
Melitara junctolineella, 420
Merrill, J. H., 125
Metcalf, C. L., 196
Metcalf, Z. P., 396
Micromus posticus, 448
Middleton, Wm., 446
Monarthropalpus bupi, 435
Monroe, W. M., 380
Moore, Wm., 172, 205, 206
Musca domestica, 359

Newell, Wilmon, 263
Nezara viridula, 440
Nicotine dusts, 95, 497
  in sprays and dusts, 486
Nipponorthezia ardisiae, 262
Nolan, W. J., 117
Nursery stock fumigation, 161

Oil emulsions, 430, 534
O'Kane, W. C., 176
Onion capsid, 79
Orchestes pallicornis, 394
Oriental moth, 292
Oriental peach moth, 393, 461
Ormenis pruinosa, 458
Orthotylus translucens, 79
Orton, W. A., 253
Osborn, Herbert, 168
Ox warble, 102
Oyster-shell scale, 392

Paratetranychus pilosus, 88
Paria canella, 283
Park, Wallace, 228
Parks, T. H., 299
Parman, D. C., 222
Parrott, P. J., 90, 190, 424
Pea aphis, 81
Peach tree borer, 376
Pemphigus betae, 378
Pepper maggot, 81
Peterson, Alvah, 81
Pettit, R. H., 98
Phillips, E. F., 117, 136
Phytophaga destructor, 288, 293, 433
Pink bollworm, 544
Plank, H. K., 99, 459
Plant diseases, 146
Plant quarantines, 251
Platygaster hiemalis, 299
Plodia interpunctella, 550
Plum curculio, 275
Popillia japonica, 312, 349
Porosagrotis orthogonia, 327
Porthetria dispar, 39
Post-Graduate studies, 182
Powder post beetles, 226
Presidential address, 31
Primm, J. K., 435
Pseudaonidia duplex, 43
Pseudococcus maritimus, 552
Pyrausta nubilalis, 317

Quarantines, 251–262
Quayle, H. J., 328
Quaylea whitteri, 513

Rea, Geo. H., 133
Red bug, 548
Red spider, 88
Refrigerator, shipping, 539
Regan, W. S., 206
Rhagoletis tabellaria, 99
Rhopalosiphum persicae, 490
Rice weevil, 99
Rockwell, F. F., 146
Rosy aphis, 93
Roth, F. C., 463
Ruggles, A. G., 51

Salmon, S. C., 293
Sanders, G. E., 205
Sanders, J. G., 31
San Jose scale control, 209, 395, 552
Sarcophaga sternodontis, 227
Sasscer, E. R., 84, 152, 165
Schizotetranchus schizopus, 96
Screw-worm repellents, 222
Scutellista cyanea, 459
Scymnus binaevatus, 516
Searles, E. M., 363
Seasonal adaptation, 420
Severin, H. H. P., 97, 479
Shotwell, R. L., 392
Simmons, Perez, 357
Sitophilus oryza, 99
Smith, H. S., 506, 516
Smith, L. B., 349
Smith, M. R., 555
Smith, R. H., 201
Smith, R. I., 84
Snail poison, 456
Snapp, O. I., 275, 552
Sodium flouride, 374
Soldier bug, green, 440
Solenopsis geminata, 97
Sparganothis ideausalis, 304
Spirea aphis, 92
Spraying equipment, 494
Spreaders, 201
Spreader tests, 198

Spruce budworm, 54, 56, 59
Squash bug, 73
Stahl, C. F., 476
Stear, J. R., 96, 458, 548
Stearns, L. A., 198
Stigmus fulvicornis, 554
Strawberry rootworm, 283
Striped cucumber beetle, 363
Strong, L. A., 266
Sugar-beet web-worm, 378
Sugar-beet root-louse, 378
Summers, J. N., 292, 539
Swaine, J. M., 249

Tabanidae, 307
Tabanus atratus, 309
  flavus, 308
  imitans, 310
  pumilus, 311
  trimaculatus, 310
  turbidus, 309
Tanquay, M. C., 113
Thomson, J. W., 312
Thurberiphaga catalina, 544
Tobacco dust, 90, 424
Trichogramma minuta, 98
Trichopoda pennipes, 77
Trimble, F. W., 263
Tropical fowl mite, 228
Tropical quarantines, 263
Trundy, J. H., 314
Turner, W. F., 440

Utah insects, 377

Vacuum fumigation, 84, 317
Van Dine, D. L., 353
Vansell, G. H., 412
Van Zwaluwenburg, R. H., 227

Wakeland, Claude, 96
Webb, J. L., 544
Weigel, C. A., 84, 283
White pine weevil, 59
  snail, 522
Whither in Entomology, 29
Willard, C. J., 388
Wireworms, 553
Woglum, R. S., 518
Worthley, H. N., 73

Yellow fever mosquito, 97

Zoological Record, 228

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